THE
ENGINEERING MAGAZINE
THE WORLD IS ITS FIELD

VOL. XXXIX. AUGUST, 1910. No. 5.

THE MANUFACTURE OF FRENCH AEROPLANES.

By Warren H. Miller.

The picturesque and emotional appeal of mechanical flight, in our estimate, has caused popular imagination to run away with judgment in tracing the future of the aeroplane. However, dismissing the question of its economic or commercial importance, it is certainly a highly interesting mechanical development, with some industrial significance so far as manufacture is concerned. From this point of view Mr. Miller's review of the "state of the art" in France is prepared. A second article, following in September, will deal more specifically with the motors used in the leading French aeroplanes.—THE EDITORS.

DURING the last year or so, the main principles which govern the design of aeroplanes have become pretty fairly fixed in the minds of the French constructors, and the business side of their manufacture has developed enormously. In fact, to find Blériot passing his two hundred and fiftieth aeroplane sold; Farman, Sommer, Antoinette, and Voisin anywhere from twenty to fifty aeroplanes apiece on the books; all of them issuing handsomely illustrated catalogues of their standard sizes and types of manufactured aeroplanes, and owning from one to three factories apiece for their manufacture—this is striking evidence how far beyond the experimental stage the manufacture of French aeroplanes has progressed.

Each house has its *école;* some of them, like Blériot and Antoinette, two of them on different aerodromes, as the Antoinette *Ecole de Pau* and the Antoinette *Ecole de Mourmelon.* Each has its *directeur, moniteur,* and staff of pilots, and the total of pupils enrolled or recently graduated aggregates over four hundred. Their principal function is to teach intending purchasers of new machines how to run them before essaying any flights on their own machines. One must have a pilot's license before being allowed to fly at large on the aero-

dromes. The price of the course is about 1,000 francs and the students number scores.

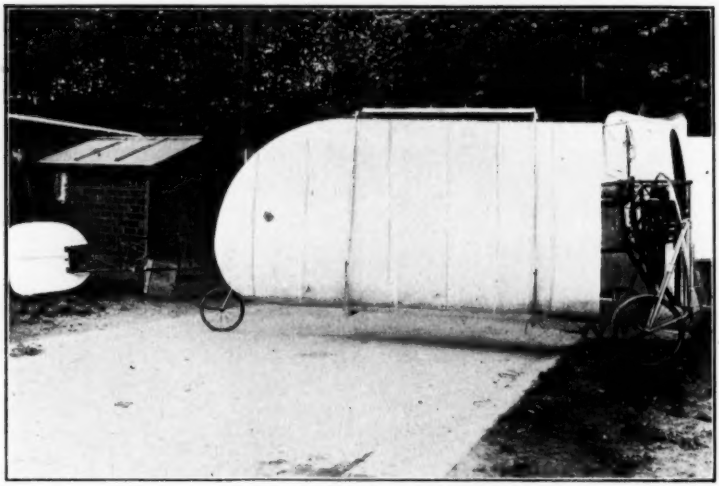
Among the few principles which have become so established that no aeroplane can be considered scientifically correct that ignores them are, first, the discovery of Langley that a plane is more efficient if presented with its longest dimension across the wind, than in any other position. If turned the other way, or if square, it is markedly less efficient. The reason is that the kinetic energy of the relative speed of each particle of air is at once taken out of it the instant that it comes in contact with the plane. It is then dead and inert, and the sooner it is passed off astern and fresh particles of air utilized, the better. Therefore a long wing like the biplane, of the proportions of, say 10:2 in length and width, is immensely more efficient with the length 10 presented to the wind, than if turned lengthwise, (as in artists' illustrations of air-ships, for example,) and the small dimension 2 presented to the wind. The second well-established principle is that a curved plane has a great deal more lifting power than a flat one. The best curvature has been found to be about 1 : 12 cord of the arc. The reasons are somewhat more complex than those for the position of the plane for maximum efficiency. Lillienthal, the German *glissardier,* was the first to investigate extensively the actual causes of this phenomenon, and his treatises on the subject explain the matter as well as need be. The third principle is that of steadying the plane laterally while in flight. Obviously there is no great trouble in preventing the thing pitching, as either a tail with feathering or a small plane in front will be ample to preserve the fore-and-aft stability while in flight; but sidewise it is a different matter. One would think that the principle of Santos-Dumont, as exploited in his 14-*bis* biplane, would be ample to insure an even keel; but, unfortunately, the principle of having the center of gravity below the point of support does not work as efficiently in air as on the sea. There are numerous planes employing this idea, the wings extending in a wide V with all the weight at the bottom. It should then always remain automatically upright—and it will, when falling, just like a shuttlecock; but when under way, the aeroplane can dip considerably from one side to the other because it is swimming through the air horizontally, not falling, and the forces of suspension passing along the frame to the load make the feeble couple between the load and the center of suspension (wherever that may be) of very little significance. Undoubtedly the best way to keep the aeroplane on an even keel is to use some of the force obtained from its passage through the air to keep the plane steady, and this can be done either by warping the wing-

BLÉRIOT XI IN FRONT OF NEUILLY FACTORY.
Equipped with Anzani motor.

tips, or by putting on little wings at the tips which can be moved out of the general angle of the plane, and thus exert a lateral couple, or else by warping the horizontal feathering. Still another way is the vertical cellular plane principle of the Voisin and other French planes, though this is not as positive in its action as the others, because the plane can tip considerably before it comes into play. It is the use of this warping principle and its patent by parties in America that has stirred up such a row among the French, but a discussion of the pros and cons of it lies outside this article.

With these three principles properly provided for in the aeroplane, and a light motor, one has the means for flight through the air; and their combination in five different ways has brought into the field of French aviation the five large manufacturing concerns mentioned above.

Beginning with the Blériot *Compagnie Aeronautique*, main offices 16 Rue Duret, Paris, and four factories in the suburbs, we find an enthusiastic *clientèle* buying freely of the two standard sizes, Blériot XII and XI, with M. Blériot himself constantly on the grounds at the Pau aerodrome, supervising flights, etc. No. XI is the same size as that in which Blériot crossed the Channel. It weighs 750 pounds, has a wing surface of 150 square feet, length from tip to tip, 28 feet 3 inches, length from front of screw to tip of rear rudder, 26 feet 5



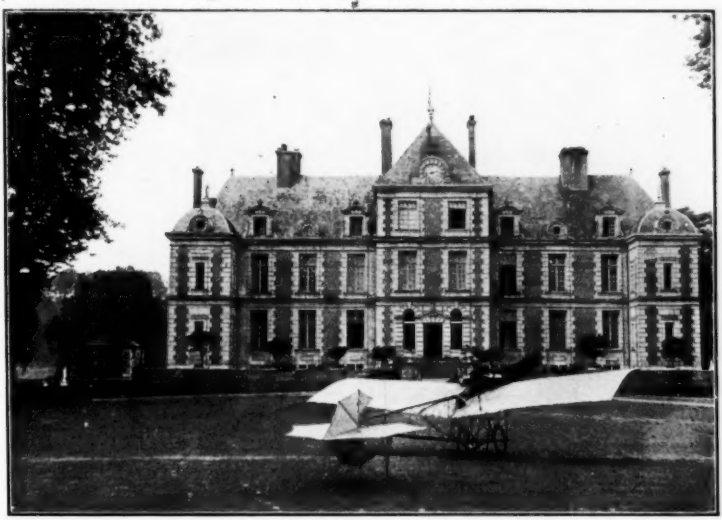
BLÉRIOT XI WITH WINGS FOLDED.

inches. It is sold on prompt delivery with a 25 horse-power Anzani motor, with a guaranteed speed of 44 miles an hour. The No. XII is considerably larger and heavier, and will take a passenger. It weighs 1,050 pounds, has a wing surface of 292 square feet, length from tip to tip of 32 feet, and length from front of screw to tip of rudder of 22 feet 5 inches. It is furnished with a 60 horse power E. N. V. motor, and a speed guaranteed of 48 miles an hour. Both aeroplanes have an angle of incidence of 7 degrees of the wings with the horizontal, the angle being measured by the cord of the arc and a horizontal line. Both ensure lateral stability by warping the main wings, but the latest model of No. XII has this command transferred to the tail. In it, as will be seen by the cuts, the framework is enclosed in light cloth, owing to the recent discoveries this year that the frame offers very much less resistance to the air when covered by some smooth surface, the weight of the latter being amply compensated for by the gain in speed. The frame of the aeroplane and wings is of ash covered with rubberized linen, all tension members being of steel piano wire.

Closely allied to the Blériot is the Antoinette monoplane, made famous chiefly by the exploits of Hubert Latham. The control of lateral stability is by torsion of the main wings, though in *Antoinette V*, in which Latham made his splendid performances, the control was by little wings at the rear outer corners of the large ones. The frames of both the wings and body of this aeroplane are of steel, and the

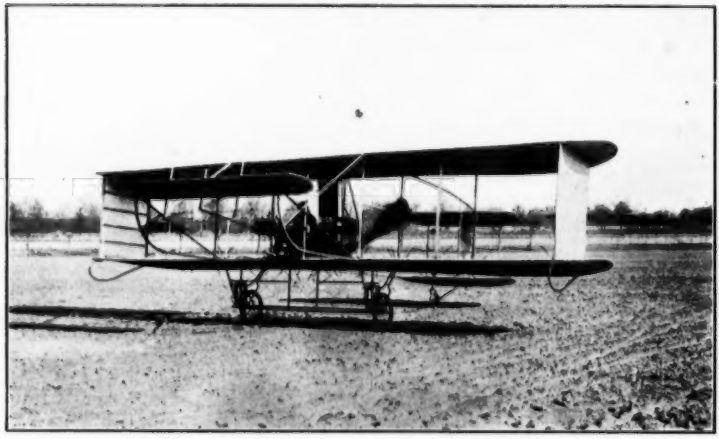
wings are covered with varnished linen on both sides, yet do not weigh more than 0.2 pound per square foot. The machine is only made in one size, with a 50 horse-power Antoinette motor. It weighs 1,150 pounds, has a wing surface of 345 square feet, is 48 feet 6 inches from tip to tip, and is 37 feet 9 inches from front of screw to tip of rudder. It always shows great stability of flight, doubtless due to its heavy solid construction and generous vane surfaces in the tail. It was the first one to have its frame covered with varnished linen, so as to prevent loss by the friction of the air strumming through the frame members.

The third monoplane to be mentioned is the little *Demoiselle II.* of Santos-Dumont. This is made by the Clément-Bayard Company, so well-known for their automobiles and dirigible balloons. It is the smallest of the monoplanes, having only 120 square feet of lifting surface, and is in the line that it seems the monoplanes will eventually take, of being used for single travel, like the bicycle during the '90's. The biplanes, with no physical impossibilities prohibiting their development into multiplanes, appear to have the logical elements of heavy duty and passenger transportation. The plans of this aeroplane are given in the illustrations. The frame is of steel throughout, and the motor, a Clément-Bayard 25 motor, is mounted at the junction of the wings. These are set in a V, as in all Santos-Du-



THE "DEMOISELLE" OF SANTOS-DUMONT.

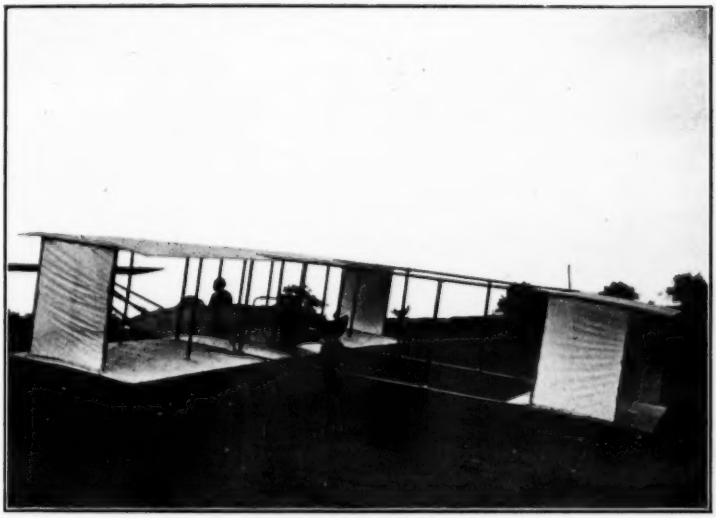
mont's designs, but the lateral stability is further assured by warping of the wings themselves. Considerable study has been shown in the arrangements for control, which form so great a part of the worries of the man at the helm. The pilot has to perform five manœuvres in managing an aeroplane, some of them all at once, viz. 1, governing depth and longitudinal equilibrium; 2, steering; 3, governing lateral stability (by warping); 4, managing the carburetor; 5, advancing the spark. All of the aeroplanes have various ingenious schemes for doing three or four of these things at once—Blériot by various positions of the shaft of the steering wheel, Antoinette by three wheels and a foot lever; Dumont manages the motor with the feet, the depth rudder with his right hand, and steering rudder with his left. This leaves the lateral stability with no hand or foot to take care of it, so he has attached the wires that warp the aeroplane to the seat where the pilot sits. By simply bending away from the direction of dipping, the plane is warped, by the stock of the seat, so as to bring it level again. Details of *Demoiselle II;* weight 230 pounds, spread of wings 18 feet 0 inches, length 19 feet 6 inches.



THE CLÉMENT-BAYARD BIPLANE.

The first of the French biplanes is undoubtedly the Farman. It holds four of the world's records at present, that of height by Paulhan, 1,520 metres, of distance by H. Farman, of 232 kilometres, of duration by H. Farman of 4 hours 17 minutes 3 seconds, and of cross-country flight by M. Farman. It will carry three to four passengers, and is very easy to handle. It is manufactured by Messrs. Farman, Kellner & Neubauer, 218 Boulevard Périère, Paris, factory at

Boulogne-sur-Seine. When you purchase, a flight of fifteen minutes with your aeroplane by one of the company's pilots constitutes the acceptance test. The biplane is made in one size, weighing 1,200 pounds, 430 square feet, carrying surface, 32 feet 9 inches length over all of plane, 39 feet 6 inches length from tip of forward governing plane to end of rear supporting cell; speed 40 miles per hour.



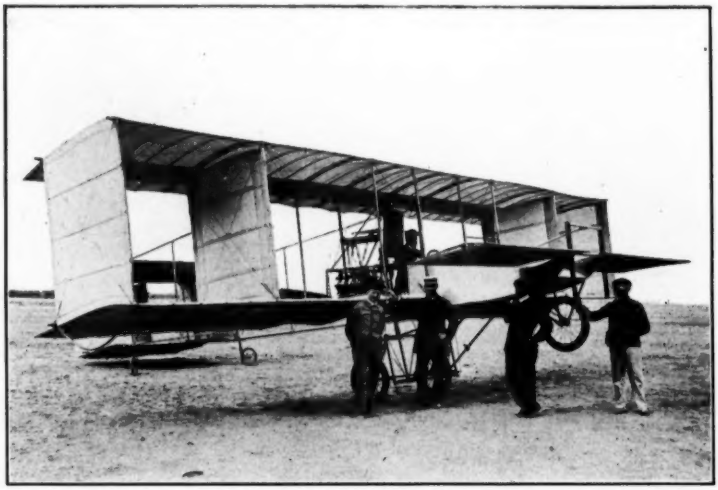
THE FARMAN BIPLANE.

Equipped with 60 horse-power Renault motor, or with 50 horse-power Gnôme motor. The frame is of ash with piano-wire tension members. As will be noticed from the cut, the screw, which is made of wood glued up in sections, is placed behind the main plane, thus avoiding the confusing effect of a whirling screw in front of your eyes, and also possibly giving a trifle better efficiency, as the plane only meets air currents in right lines. With the long tail astern, and a governing plane out in front, the control of longitudinal stability is easy and perfect. It is managed by the steering wheel, the joints being ball-bearing, as are all those about the apparatus. The steering rudder is managed with the feet, and the lateral stability by the main steering wheel, which turns to right or left and raises or depresses the little wings or fins at the rear edges of both planes. The lateral stability is further aided by the vertical planes in both main and rear cells.

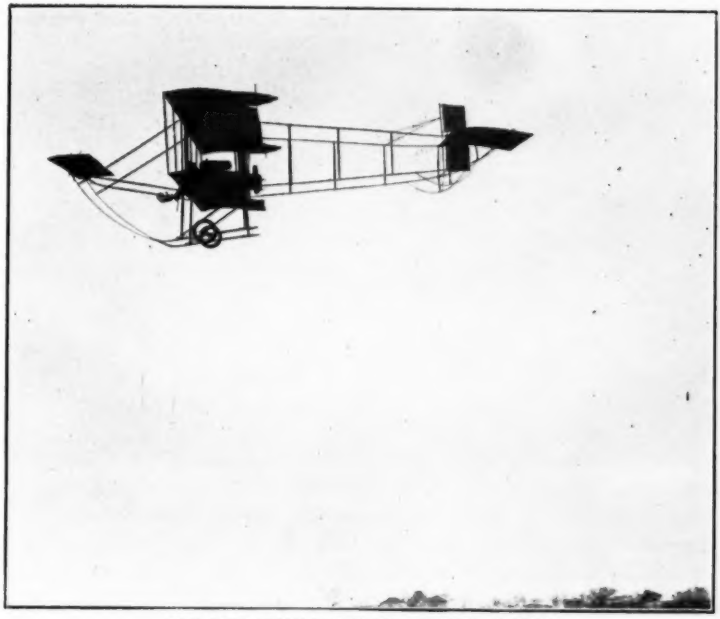
The oldest and most famous of the French biplanes is the Voisin, manufactured by MM. Voisin Frères, offices and factory at 34 Quai

du Point du Jour, Billancourt (Seine), Paris. Their aeroplane is on the market in one size only, with Gnôme motor. It weighs 1,200 pounds, has a portative surface of 540 square feet, length from tip to tip of wings, 37 feet 8 inches, length from front edge of stability-plane to rear edge of tail-cell, 39 feet 4 inches; speed, with 50 horse-power motor, 40 miles an hour. The stability is assured entirely by the vertical planes, which divide the bi-plane into cells. The tail-cell has the same feature with the rudder mounted inside. In practice it works out about as well as the warping principle, which has been abandoned in the latest types of Blériots and Antoinettes.

The latest of the French biplanes is the Sommer, shown in the illustrations. It has been long known by the cellular men that their planes have a great deal of encumbrance of doubtful utility, particularly in the tail. This can have but little effect as a supporting plane, unless the main weight is placed further astern than at present, as the couple it makes is so great about the center of longitudinal stability as an axis that it cannot support very much more than its own weight. Any further lifting capacity would be simply spent in overturning the plane or in imposing unnecessary work on the forward stability-plane. It will be noted that the Sommer aeroplane has discarded the lower of the tail-planes and placed the rudder further forward in the tail-frame. The cellular feature is discarded in favor of the much-disputed rear-vanes of lateral stability. The whole aeroplane has

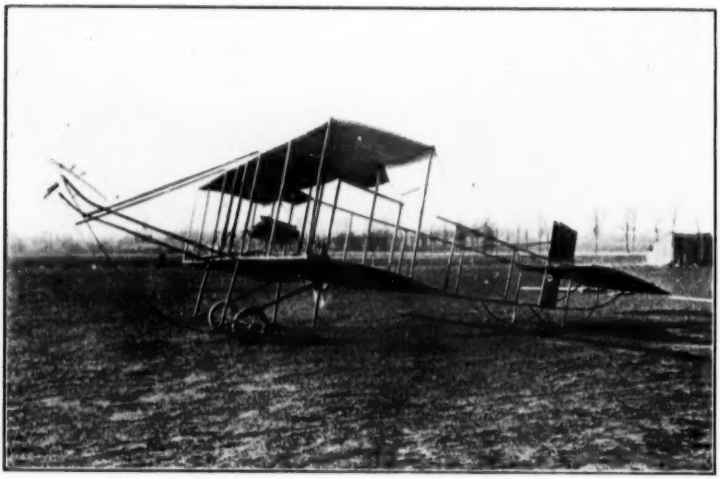


THE VOISIN BIPLANE.



THE NEW SOMMER BIPLANE IN FULL FLIGHT.

greater care for the practical needs of aviation shown in its design than most earlier makes, being, as might be expected, the design of a man already thoroughly familiar with just what requirements are most needed in practice. The arrangements for protection against the shock of landing are very complete and well studied out. The sled frames of Wright have been introduced, in addition to the regular French steel chassis with its deadening springs, which is a feature of every French aeroplane. The sled frame has been substituted for the lower supporting plane in the tail, besides, so that if the aeroplane bobs or teeters on landing, the runners of the sled will protect both the aft tail-plane and the forward stability plane. Unlike the Blériot machines, which have always preferably the members of the frame in light springy woods (better able to withstand shocks of landing, etc.) the Sommer aeroplane has its members entirely in steel. The joints and hinges are of special alloy, and their pins of high-speed steel. The apparatus can be dismounted and reassembled in an hour, without disturbing the chassis, and, when folded up, can be run along ordinary country roads. All the wires of control are double, and the rear plane interlocks with the mechanism of the forward stability-



THE SOMMER BIPLANE AT REST.

plane, so that the pilot has little on his mind in maintaining longitudinal equilibrium.

This machine has made flights with 360 pounds of supercargo. Main construction details are: length across main planes, 32 feet 8 inches; portative surface, 368 square feet; weight with Gnôme 50 horse-power motor, and Chauvière aluminium screw, 670 pounds; speed, 50 miles an hour; planes covered with rubberized linen.

The prices of all the large aeroplanes are close to $5,000; those of the smaller machines (such as the Blériot monoplane), about $2,500.

It will be seen that the Sommer is at present by far the lightest of the biplanes, which, with its portative surface of only 388 square feet enables it to carry such a heavy supercargo, because so much less dead weight is imposed on the aeroplane. The motor-power also drops, or, what is the same thing, the speed increases with the same size motor. Altogether is it a fair hint of what will gradually come to be realized in the future of aviation, as constructional details become more and more perfected. When we review the progress made by the bicycle in a few years, from the heavy iron 70-pound wheels with solid tire of 1890, to the 17-pound beauties of 1900, with their light, strong steel frames and pneumatic single-tube tires, we can form some idea of what will be done in the line of development in the construction of aeroplanes, when once the weight of experience and scientific data enable us to advance in the correct directions.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

V. HIGH-TENSION TRANSMISSION.

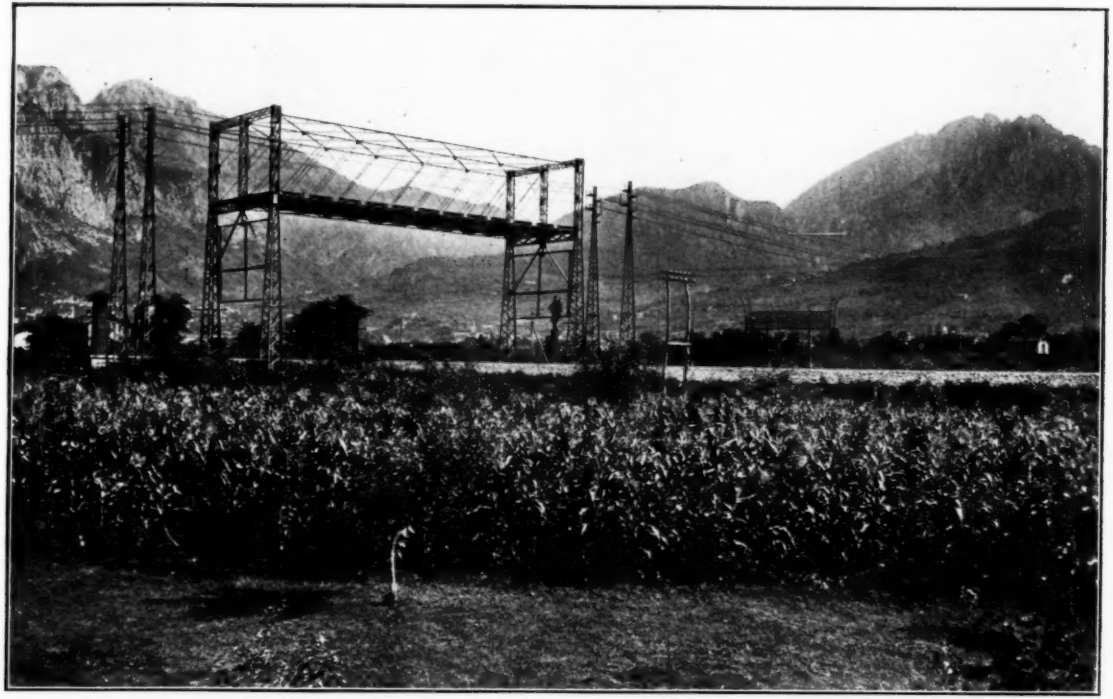
Mr. Koester's first article, published in April, was concerned with the impounding of water supplies and the attending engineering construction. His second dealt with head races, pressure pipes and penstocks. In June he took up water-wheels and the mechanical equipment of the power station. His July article considered the electrical machinery, and he now reviews the transmission and distribution of current. A following paper will take up the financial elements of the case. The whole discussion is addressed not to the specialist in hydroelectric engineering, but to those who will value a concise review of the foundational elements in good modern practice—whether as contractors, owners, managers, or financial and commerical associates.—THE EDITORS.

A TRANSMISSION line should run at low levels and near highways, to facilitate erection, inspection, and repairs; and the line should be as straight and short as possible in order to minimize first cost, maintenance, line loss, and the expenditure of securing right of way. Where the line runs through mountainous country, high peaks must be avoided because the temperature range between peak and valley is great and atmospheric electrical discharges are frequent. It is therefore better policy to detour the line than to be troubled with atmospheric discharges.

For high-tension lines of some magnitude two separate circuits should be run either on a common line or two separate lines of supports so that one is always in reserve. Each line must be divided into sections, provided with section-switches and by-pass connections so that continuous service may be assured. Stations for linemen, repair shops, etc., may be established for each section, which will cover from 10 to 20 miles of transmission, and from these points inspection and repairs may be undertaken.

Telephone lines for communication between the stations and the main central station must be established. Proper precautionary measures must be taken if run on the transmission line; otherwise the telephone lines should be carried on separate poles.

For carrying the conductors of the main transmission system the following pole and tower constructions are used, viz: wooden poles, concreted wooden poles, reinforced-concrete poles and towers, steel-pipe poles and towers, and structural-steel towers. Of this variety wooden poles and structural steel towers are chiefly used.



TOWERS AND CROSSING OF THE 50,000-VOLT BRUSIO TRANSMISSION SYSTEM, SWITZERLAND-ITALY.

Where the transmission line runs through a section or in the vicinity of a forest district where poles may be cut, the wooden pole is preferably selected on account of cheapness, little or no transportation, and ease of erection. The disadvantages of wooden poles are, that they decay very rapidly; more insulators are required owing to the short spacing between poles; they are easily destroyed by storm, lightning and fire. The ordinary type of line construction is a single pole. Other types are the "A" frame and "H" frame, both of which require two poles. The kind of wood used depends upon the locality, the cost, and factor of safety desired. In western American transmission lines spruce and fir are much used, while in California redwood prevails. Cedar and chestnut are also used, white pine, owing to its cheapness, is used most extensively, but it has the disadvantage of short life and inferior strength.

The life of wooden poles depends upon the nature of the wood, chemical treatment, and climatic conditions, and also upon the character of the soil. Redwood and cedar poles may last 20 years under favorable conditions, while the life of chestnut is about 15 years and that of pine and white cedar 10 years. When chemical treatment is applied the life of all wooden poles may be materially increased. Poles come in lengths varying from 30 to 60 feet, and they are set with 1-6 to 1-7 of their length in the ground. The cross arms for carrying the insulators are made of first-class wood, such as chestnut, white oak, cedar, redwood, etc. Arms 8 feet long are 4 by 5 in cross section, 3-foot arms about 3 by 4 inches in cross section. They must be properly braced to withstand the strain applied, and fastened to the poles by means of lag-screws.

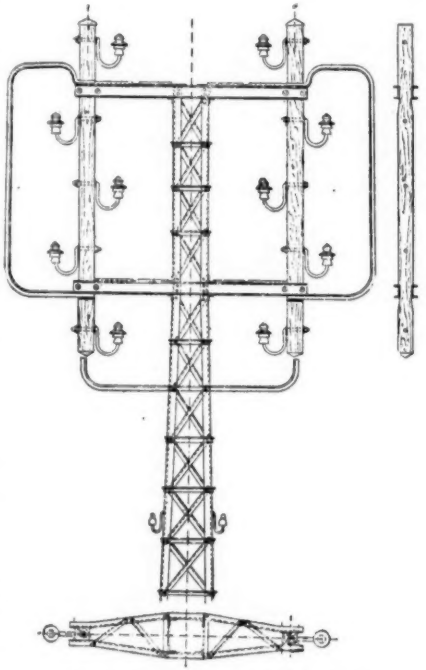
The concreted wooden pole has not been used to any great extent. Up to recently it has been used in Switzerland only, but of late it has been introduced into America. It consists of an ordinary wooden pole covered with a layer about 1 inch thick of concrete mortar. As this coating covers the entire pole it is practically indestructible, and fewer poles and insulators are needed. The concrete-block setting frequently used with ordinary poles is thus eliminated.

Reinforced-concrete poles are made in a manner similar to concrete piles. They are cast in forms and reinforced with iron or steel rods. Another type of reinforced-concrete poles is the hollow pole known as the "Siegwart," developed in Switzerland. They are of a tapered design and made by machine to any length desired. These poles are estimated to have a life of 50 years, and during this period will cost nothing for maintenance. Comparing such poles of 29 feet in length, the costs of poles at the end of 50 years are estimated at

$20 for this concrete pole, $50 for an iron pole, and $53 for a wooden pole; all including maintenance, repairs, and renewals. Some tests on poles of this type 32 feet 9 inches long show a deflection of 2¾ inch with a tensile strain of 15,000 pounds.

The simplest form of steel-pipe poles is that employing a single pipe with a cross arm. For more rigid and higher constructions two-legged pole frames or three-legged towers may be used. The latter type will be found on the Canadian side of the Ontario Power Company's transmission system and also in an earlier system installed at Juancatalan, Mexico, which was one of the first high-tension transmission systems introduced on the western side of the Atlantic.

With the use of high voltage wooden poles are fast being superseded by steel towers. These are made of angle irons, channels, and lattice construction in two, three, and four-leg types. Poles of the two-leg type have been in use for many years in Italy and Switzerland and of late years in Germany and Spain, and are at present being introduced in American practice. As they possess great economical features there is no doubt that they will at some time take a very prominent place in high-tension transmission practice. They are made up of channels or I-beams in "A" or "H" frame type and are lattice-braced. Recent plants for which these have been adopted in Europe are, the seventy-five mile, 52,000-volt Gaucin-Seville, Spain, transmission system; the thirty-two mile, 50,000-volt Moosburg-Munich, Germany, transmission system. Other towers of this type will be found in Eastern Germany and also on the Victoria Falls transmission line in Africa.



PARTIAL DETAIL OF A TYPICAL SWISS TRANSMISSION TOWER.

The following table, based upon tests made upon the different constructions before the contracts for the Moosburg transmission system were let, shows the comparative values of different poles:

	1	2	3	4	5
Res.-Mom. in line direction	990	32.2	33.9	353	52
Res.-Mom. in transverse direction	5,440	32.2	33.9	353	52
Safe load in kilograms..	100	1,800	2,200	870	1,800
Cost in marks, including two cross-arms	35.20	40.35	45.20	80.70	40.00

Referring to the column numbers, No. 1 is a wooden "A" frame structure, 2 is a steel two-pole, 3 is a Mannesmann-tube pole, 4 is a lattice tower of angle iron, and 5 is an I-beam "A" frame. It will be noticed that the last named outstrips the other as to safe load and price. All these towers were designed for a height of 23 feet to the lower insulator and were imbedded 5 feet in concrete blocks.

The above mentioned three-legged steel-tube tower is no more in favor but a substitute has been successfully introduced in which each of the three legs consists of a special U-shaped rolled steel member.

The transmission tower used most extensively in America up to the present time is the four-legged tower made of four angle-iron legs, braced with angle irons or flat bars, diagonal bracing being frequently made of rods. The arms for carrying the insulators may be of structural steel or wood.

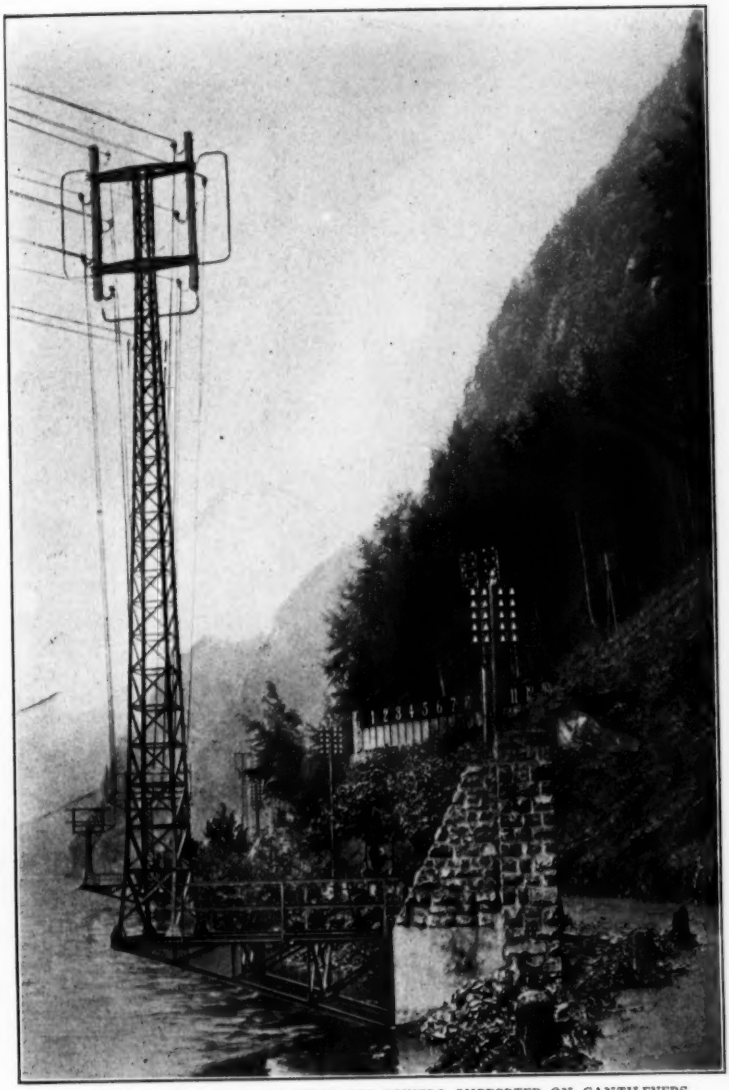
A novel method for supporting a transmission tower is found in connection with the 27,000-volt lines of the Lucerne, Switzerland, transmission system. The towers are about 45 feet high, measured from the ground to the top of the lower insulators, which latter are mounted on vertical oak members carried by transverse channels. They are fastened to galvanized-iron pins by means of hemp, linseed oil, and shellac. To prevent a line from dropping to the ground guard angles are provided. Owing to adverse conditions several of the towers had to be placed on cantilever constructions overhanging the lake. For this purpose the cantilever structures had to be imbedded in heavy concrete blocks in order to protect the cantilever and the tower from boulders rolling down the mountain slope; heavy masonry abutments were placed on top of the concrete block; a passage is provided to reach the tower. The total length of the cantilever is 30 feet, while the spacing of the towers is 400 feet.

In laying out a transmission line it is of foremost importance to determine upon the most economical span; that is to say, after the size of conductor has been calculated, not omitting the line loss, the next step is to ascertain the proper spacing. The material used for

conductors is copper, hard or soft-drawn, aluminium and steel; all are used in cable form, while a solid conductor of copper is sometimes used. Hard-drawn copper is mostly used as it has an ultimate tensile strength of 60,000 pounds per square inch, while that of soft-drawn copper is only 30,000 pounds. The resistance of the former is 5 per cent greater than that of the latter. Aluminium has a tensile strength of about 28,000 pounds per square inch, while steel varies greatly, averaging 100,000 pounds. Comparing the specific gravities of aluminium and copper, the latter is about 3.3 times as great, so that for cables of equal length and resistance, the copper cable is twice as heavy as the aluminium. As the tensile strength is only about 28,000 pounds per square inch, aluminium wires must be used only in the form of cables. For equivalent conditions the diameter of an aluminium cable is 1.28 times that of copper, while the cross-sectional area is about 1.65 times larger, because the conductivity of aluminium is only 63 per cent of that of copper. Aluminium cables present a larger surface to the wind and also for the formation of ice. The advantages secured in the use of aluminium are, it is cheaper than copper and light in weight, which in turn reduces the cost of the line construction. Owing to the high coefficient of expansion, aluminium wires must be strung in spring or fall.

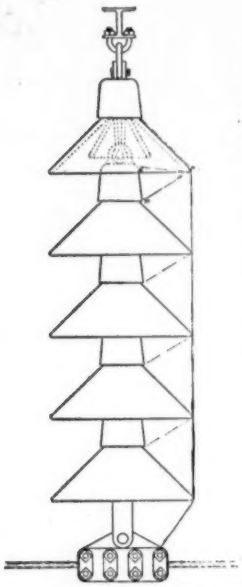
According to the law of transformation, the higher the voltage the smaller the current for a given amount of power. So far as the transmission line itself is concerned the highest voltage which can be produced commercially is the most desirable. A small current on a line means that the size of the conductor can be reduced until the mechanical strength predominates. The use of high voltage reduces the line drop, losses in transmission, and gives better regulation.

The essential factors for calculating the size of line conductors are: the load to be transmitted, the voltage desired at the receiving end, the permissible loss of energy in transmission; the frequency, spacing of wires, and length of transmission line. In calculating the size of a transmission conductor it is poor policy to use a larger conductor than is absolutely necessary. This fact is well illustrated by the law developed by Lord Kelvin. The usual way of stating it is: "The most economical area will be that for which the annual interest on the capital outlay equals the annual cost of the energy wasted." A more precise statement of the same proposition is given by Gisbert Kapp: "The most economical area of a conductor is that for which the annual cost of the energy wasted is equal to the interest on that portion of the capital outlay which can be considered to be proportional to the weight of the metal used."



27,000-VOLT TRANSMISSION LINE AND TOWERS SUPPORTED ON CANTILEVERS, LUZERNE, SWITZERLAND.

The spacing of the conductors depends upon the voltage and the length of spans. It varies from 24 to 96 inches. The increase in spacing increases the inductive drop and also the line loss. The following approximate distances are observed: for voltages from 5,000 to 10,000, 24 to 36 inches; for 10,000 to 30,000, 36 to 60 inches; for 30,000 to 60,000, 60 to 84 inches; for 60,000 to 100,000, 84 to 96 inches.

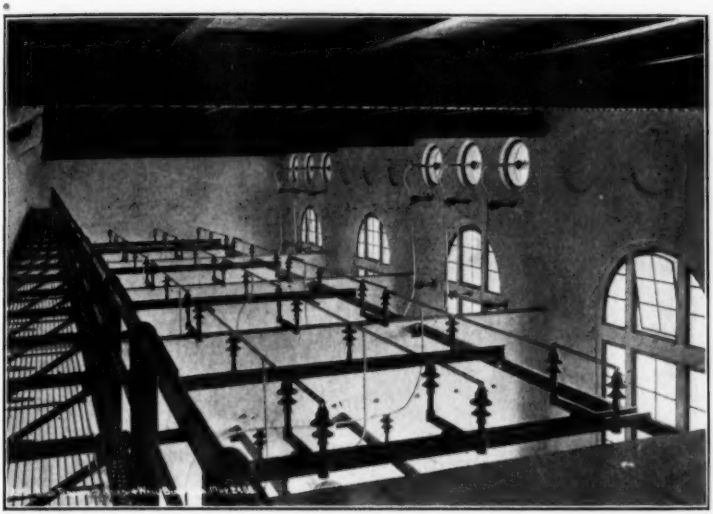


SUSPENDED INSULATOR.
Showing progressive breaking down between beginning of leakage and maximum arc.

With high-tension transmission systems multi-petticoat porcelain insulators are extensively used, and with voltages above 60,000 the link insulator is employed. The former is carried on pins, the latter is suspended. The petticoat types are made in several sections cemented together in the manufacture, and in exceptionally large sizes they are frequently cemented in the field. When this is done care must be exercised to prevent the cement from being chilled while setting; the cement mixture must be a fine rich mortar free from impurities. Besides the electrical stresses the insulators must be strong enough to withstand the mechanical stress imposed on them by the span.

The reason for using suspended insulators is largely a matter of cost, since it is entirely possible to make porcelain insulators of the petticoat type of sufficient size to operate successfully on any voltage, but the extreme height and diameter of any pin-type insulator necessary for 100,000 and 150,000-volt transmissions makes the use of that type prohibitive. The suspended type consists of a number of discs linked together by iron rods or short pieces of cable. Each disc represents a certain amount of voltage, usually about 20,000 to 25,000 volts. One of the first transmission systems installed in which the suspended type of insulator was used is that of the Muskegon Grand Rapids Power Co. The diameter of a disc is about 10 inches, and the rated voltage which each link will withstand is 25,000, although the links are over when wet at approximately 60,000 volts each.

Where high-tension wires leave or enter a building the outlet must be protected against the weather. This is accomplished by



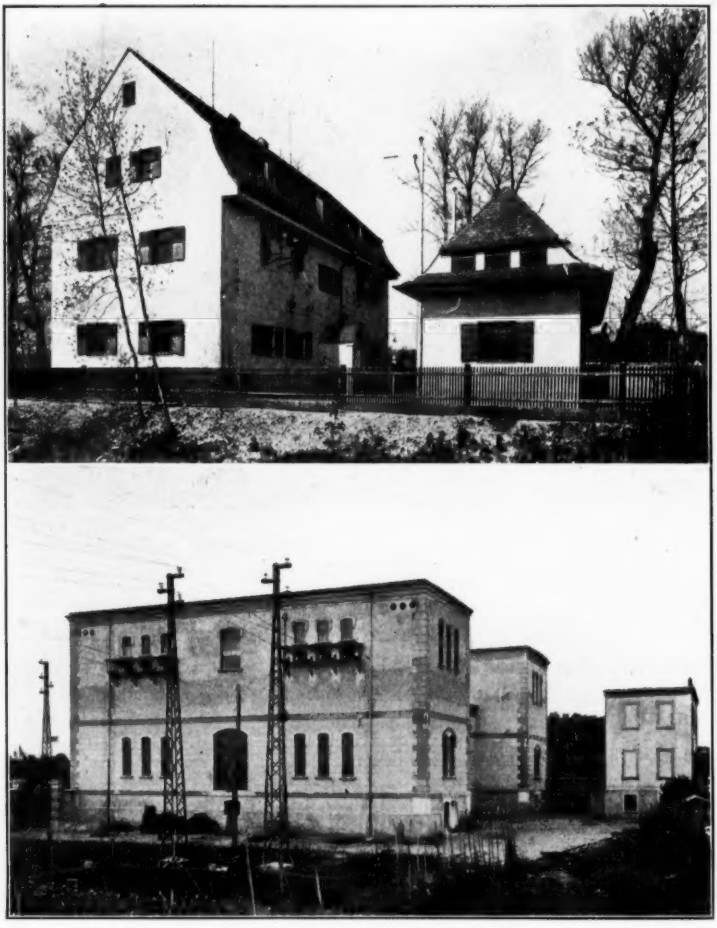
HIGH-TENSION BUS BARS AND OUTGOING FEEDERS. DISTRIBUTING STATION OF THE ONTARIO POWER CO.

either building a hood over the wall opening or by inserting insulating bushings in the wall. Another method is to lead the conductor through a hole in the glass plate; the hole being about ¼ to ⅜ inch larger than the conductor. Insulators are placed on both sides of the glass plate so that the section of the conductor passing through the wall is always taut. In Western plants and on the Pacific coast we frequently find an 18 to 20-inch tile pipe for wall outlets provided with a pierced glass plate cover. The tile pipes and bushings used for wall outlets must be set on a slant so that collected moisture can drain off outdoors.

Sub-Stations.

Sub-stations or receiving stations are designed to act as distributing centres of the electrical current. They are as a rule located as near as possible to the centre of gravity of the system of distribution. This cannot always be done, however, as the demands on a station vary in certain sections during the different seasons, particularly in street-railway operation. In many cases, to help out in such instances, portable sub-stations are transported to the centres of increased demand and remain until the load on the line can be taken care of by the sub-station proper.

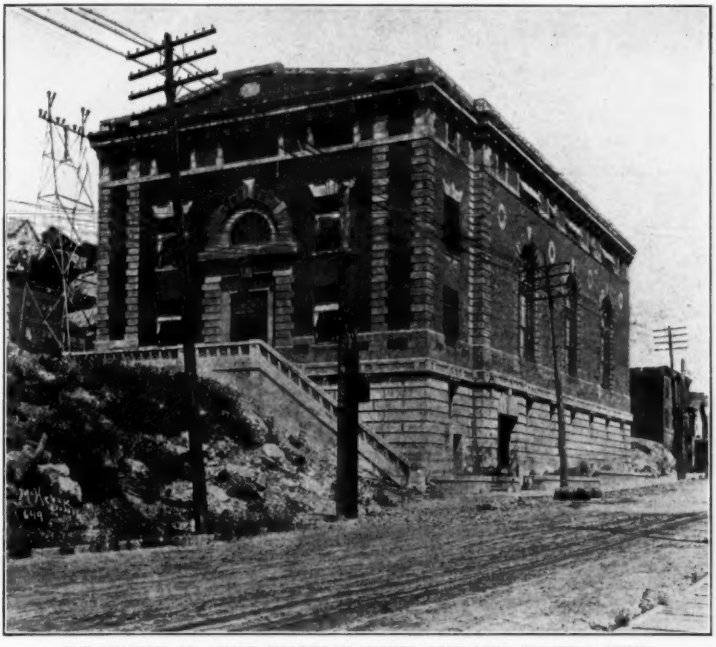
One of the most important elements in modern sub-stations is the transformers for stepping-down the high voltage to that which is desired for local distribution. Transformers are either single-



ABOVE, TRANSFORMER STATION AND LIGHTNING ARRESTER HOUSE, HIRSCHAU-MUNICH 50,000 VOLT TRANSMISSION SYSTEM. BELOW, STEP-DOWN TRANSFORMER STATION 50,000-11,000 VOLTS, LOMAZZO, ITALY.

phase or three-phase and shell or core type. The latter is more extensively used abroad and made three-phase. In America besides the core type the shell type is widely known, but chiefly in single-phase design. The advantage of the three-phase transformer is greater compactness and lighter weight, resulting in a considerable saving in first cost of transformer itself, and a saving of about 30 per cent

in floor space. The connections with the transformers are simpler and fewer in number than in three single-phase units. The method of winding and insulating is practically the same as in the single-phase transformers.

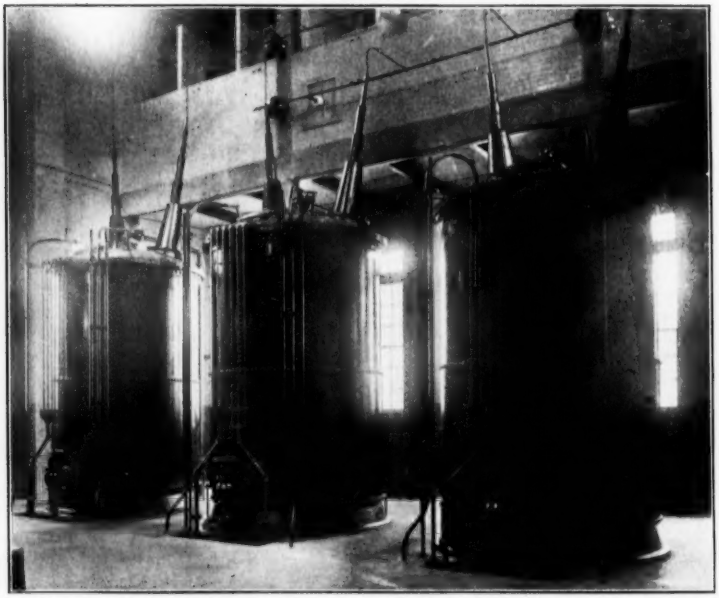


SUB-STATION OF GREAT NORTHERN POWER COMPANY, DULUTH, MINN.

Aside from the reliability and safety of operation of a transformer the most important electrical features are the efficiency and the regulation. Although good regulation and high efficiency are always to be desired, the relative importance of the two is determined by the local conditions under which the transformer is to operate. Where power is expensive or is used at short intervals only, the efficiency of the transformer especially at light load is of great importance, but where the power is cheap the efficiency as a rule is not such an important factor.

On account of the low cost of power and the double transformation of the potential necessary, the important feature of transformers designed for use on high-voltage circuits is the regulation, and not the efficiency.

In large transformers for long-distance transmission, close regu-



WESTINGHOUSE 3,750-KILOWATT SINGLE-PHASE 100,000—6,600 VOLT 60-CYCLE TRANSFORMERS, GRAND RAPIDS & MUSKEGON POWER CO.

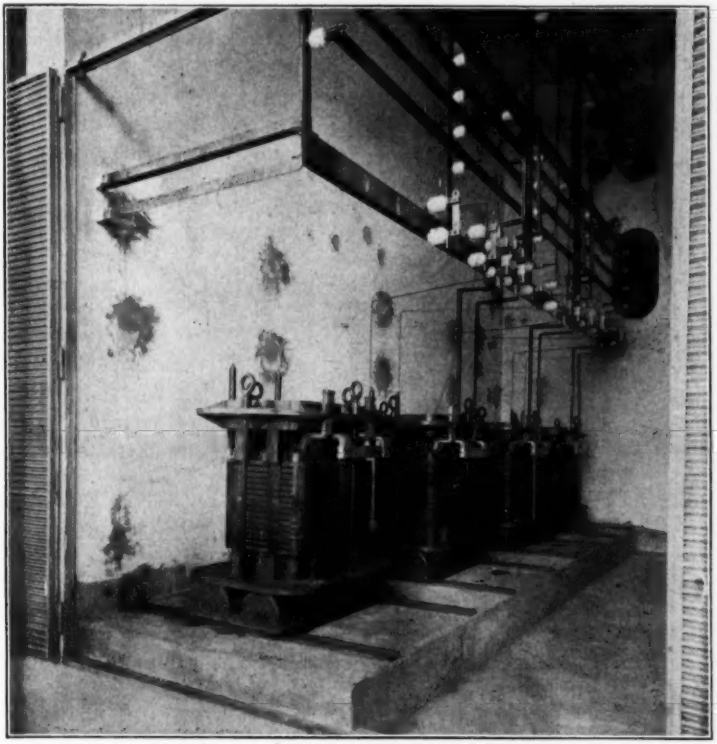
lation is of even greater importance than in ordinary small transformers for lighting circuits, as the drop in the line is of considerable magnitude and with raising and lowering transformers the transformer drop occurs twice between the generator and the load. The drop is generally increased when the power factor of the load falls below unity, is is usual in power work. The regulation of a transformer depends upon the resistance drop and the inductive drop within it. The former is fixed by the amount of copper loss at full load, the latter by the number of turns in the winding and the relative position of the coils and the space between them.

The efficiency of transformers depends on the losses, which are of two kinds, viz.: iron and copper. The former is due to magnetic reversals in the iron and is practically constant for all loads. The copper loss results from the passage of current through the conductor, and is very low for high efficiency at full load. In general, it may be stated that the efficiency of transformers is from 97 to 98.5 per cent.

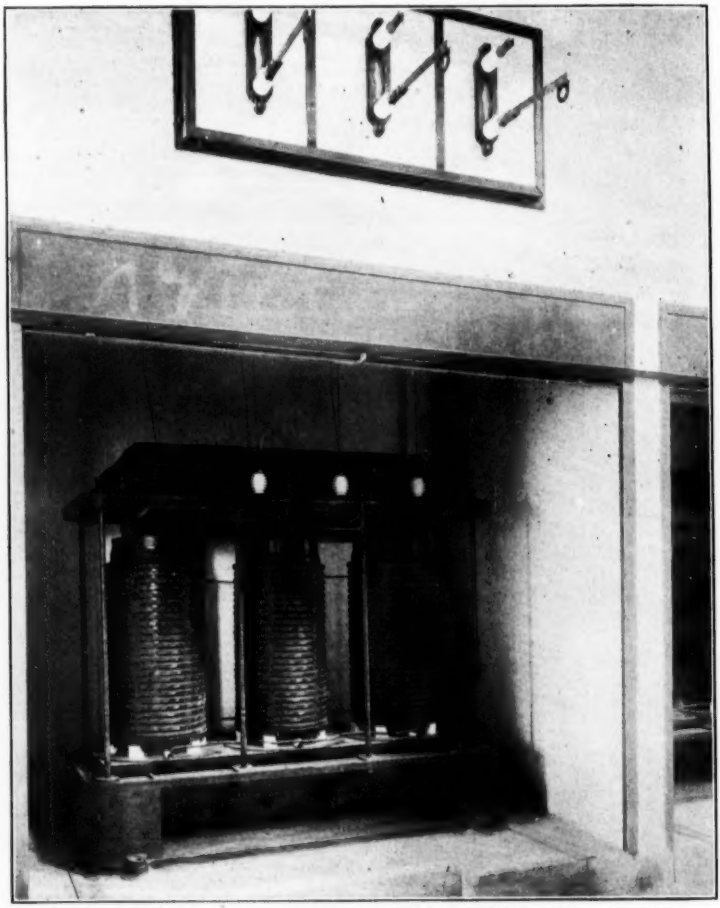
Transformers are connected in a variety of ways for transmission work: single-phase, two-phase, three-phase delta, three-phase star,

three-phase T, three-phase V, two-phase-three-phase, three-phase-star, and delta. These connections give equal voltage across any leg. To go further into detail with reference to the different connections would be out of place here.

As it is necessary to cool the transformers to give a uniform efficiency, either the circulation of oil or air may be adopted. Oil-cooled transformers are most extensively used, for the reason that oil is a better heat-conducting medium than air; besides, oil preserves the insulation, keeping it soft and pliable, and prevents oxidation by air. Consequently the use of oil maintains a uniform core loss and a superior insulation. The oil in the transformer is cooled either by natural gravity circulation or by means of submerged coils through which water is circulated. Oil-insulated water-cooled transformers are built for practically unlimited capacities and voltages. About the



250 KILOWATT 6,000—130 VOLT FORCED-DRAFT COOLED TRANSFORMERS, CASTELNUOVO-VALDARNO PLANT, ITALY.



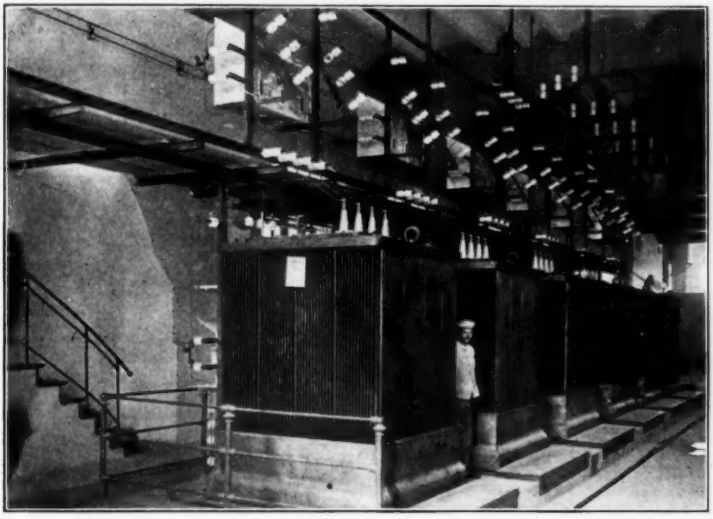
ALIOTH 5,000-KILOWATT OPEN-TYPE AIR-BLAST TRANSFORMER, LOMAZZO SUB-STATION, ITALY.

only places where they can not be used are in sections where water is extremely scarce or where the storage of large quantities of oil is objectionable. The method of cooling the transformers by forced oil-circulation has the advantage of doing away with the cooling coils in the transformers. However, a separate cooling device has to be installed on the principle of a cooling pond or surface condenser.

In the early type of transformers the cooling was done by natural air draft or by forced draft, and the latter method is still much in

vogue. The cores of the transformers are encased and the air is forced through by means of a blower.

Air-blast transformers are used where cleanliness, limited floor space and freedom from storage of large quantities of oil are features. It is for these reasons that they are principally used in large cities. They are built in all capacities and frequencies and, according to American practice, up to and including 33,000 volts. This limitation in voltage is due to the excessive amount of insulation required for higher voltages. It is possible, however, to operate air-blast transformers on circuits up to and sincluding 50,000 volts if the circuit is Y-connected with the neutral solidly and permanently grounded.



SIEMENS-SCHUCKERT AIR-BLAST TRANSFORMER, KYKELSRUD PLANT, NORWAY.

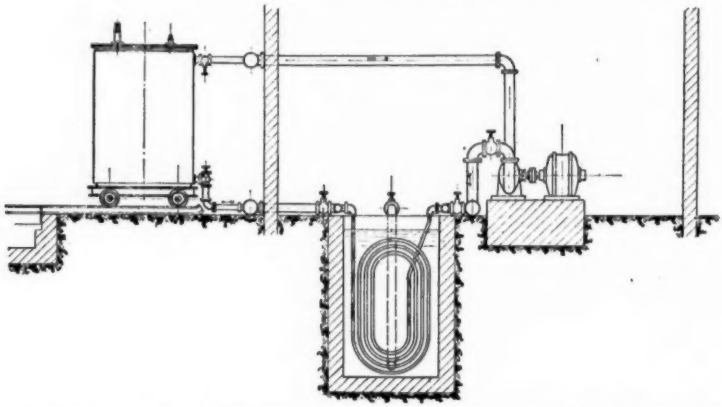
In recent Swiss and Italian practice, in connection with 50,000-volt transmission systems, a number of air-blast transformers are in successful operation without the customary casing. The cores are placed in masonry compartments provided with rolling shutters, and the air is forced into the compartment from beneath. The advantage of this setting is ready inspection without removing the core from its compartment.

All transformers should be so installed that they may be readily repaired on the spot or may be removed to the repair shop, usually adjacent to the transformer room.

It is the general practice to place oil-cooled transformers in closed compartments, and the transformers are provided with small wheels

by means of which they may be rolled on a truck and removed to the repair shop.

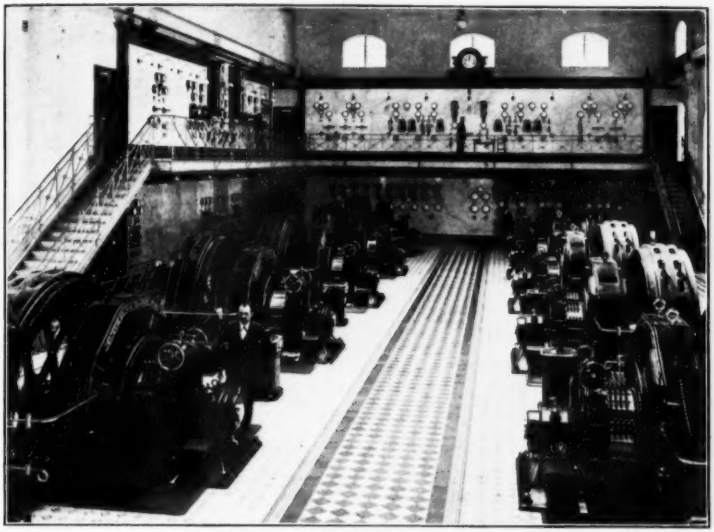
For transforming alternating current into direct current, rotary converters are installed. They may be connected to alternating mains and operate as simple synchronous motors, or connected to direct-current mains and operated as simple direct-current motors.



METHOD OF COOLING CIRCULATION WATER FOR 6,750 KILOWATT 6600—66000 VOLT THREE-PHASE SIEMENS-SCHUCKERT TRANSFORMERS, MOLINAR, SPAIN.

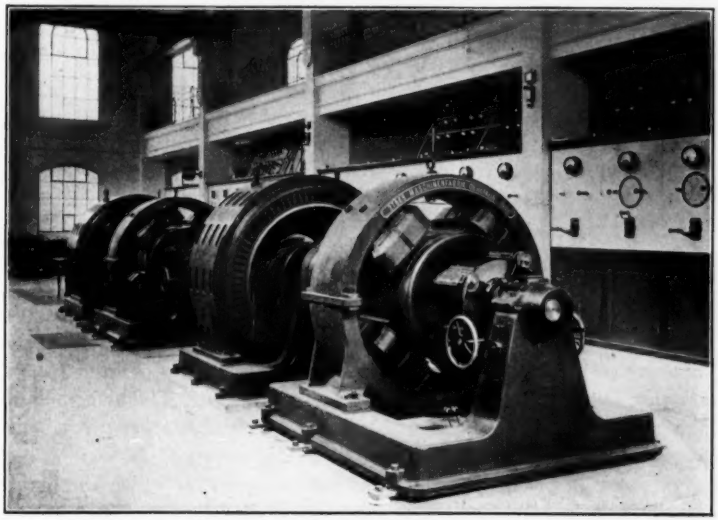
There are a number of other electrical and mechanical connections which can be applied, but the main purpose is to serve as a means of converting from alternating to direct current. Rotary convertors, in order to give the best service, must run in exact synchronism with the supply current, but it frequently occurs that the speed of the generator is not exactly uniform; and in such cases, the rotary will tend to follow the fluctuations of the generator speed, resulting in a surging action of the rotary armature alternately above and below synchronism. This is commonly known as "hunting," and often assumes disastrous proportions when no provisions are made for counteracting this effect.

When the line voltage is not too high a motor-generator set may be used in the place of a rotary convertor; the motor of the set may be directly connected to the line, thus eliminating transformers. The advantages of using a motor-generator set are, that no synchronizing apparatus is necessary, the voltage of the generator bears no relation to that of the supply, and it may be adjusted through a wide variation. The disturbance known as hunting does not exist, and when an induction motor is used as a driver no skilled attendants are necessary. The disadvantages are, that the efficiency is from 4 to 7



TYPICAL CONTINENTAL MOTOR-GENERATOR SUB-STATION, VIENNA STREET-RAILWAY SYSTEM.

per cent less than that of the transformer-convertor set, and the cost is higher. Another machine sometimes used in sub-stations is the frequency changer. It differs from the motor-generator set in the fol-



INTERIOR OF MOTOR-GENERATOR SUB-STATION, STEGHOF, SWITZERLAND.

lowing respects: the driving motor must be a synchronous motor and the generator an alternating-current machine. The generator has more or less poles than the motor, depending upon the frequency desired. Sometimes an induction motor is substituted for the generator and made to rotate above or below its rated speed. The alternating-current line is connected to the rotor of the motor, and when the rotor operates above its rated speed, the frequency is increased; when below, the frequency is decreased.

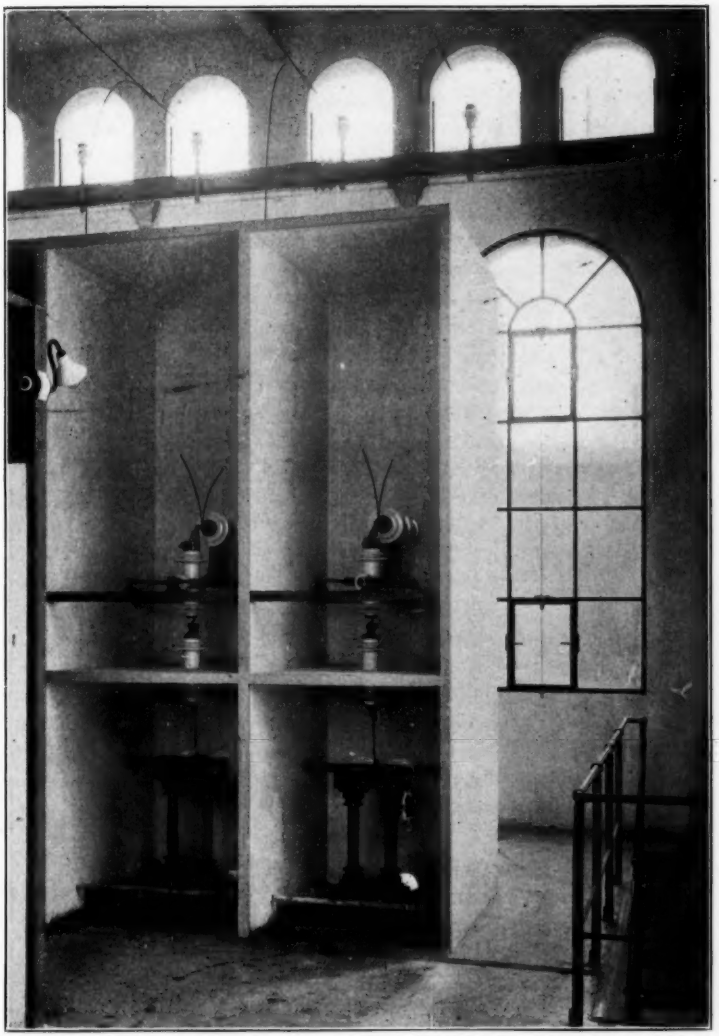
The switchgear of a sub-station is similar to that of the main generating station, and therefore need not be further discussed, as this has already been treated in the preceding article.

Line Protection.

To guard against interruption of service of the generating plant the generating apparatus must be protected, particularly against atmospheric discharges. This is done by providing the transmission system with lightning arresters or some form of grounding device. The function of this is to act as a relief vent. Various sorts of disturbances, (particularly where the transmission line runs through sections of country of different altitude), the chief of which is lightning, cause surges and oscillations in the circuit of such frequencies and high potentials as will endanger the apparatus of the generating plant, sub-station, or probably both.

The lightning arrester must permit sufficient freedom of escape of a charge from transmission lines to limit their potential to a safe value. To do this, a vent is required which will permit a very large flow of current when the potential is above a certain value, but which will suppress this flow of current quickly, quietly, and completely as soon as the potential has assumed a normal value. In other words, the arrester must permit the escape of the abnormal surge, but should preferably take no current whatever and consequently cause no additional disturbance or drop in voltage.

In general, a lightning arrester is made up of three elements, viz., an air-gap, a current-limiting element, and an arc-suppressing device. Two of these elements are always present, and usually the other is combined in some form with the other two. The air-gap holds the voltage ordinarily, but is broken over by any great excess potential, thus permitting current to flow. The current-limiting element usually appears in the form of a series resistance of some kind which limits the power current to a reasonable value. The arc-suppressing device is provided by some modification of an air-gap, and may consist of a magnetic blow-out, a mechanical arrangement by which the length of the gap is increased until the arc breaks (horn type), or non-



OERLIKON HORN LIGHTNING ARRESTERS WITH WATER-FLOW GROUNDERS, STEGHOF, SWITZERLAND.

arcing gaps consisting of a number of small cylinders with the proper spacing between them. The horn-gap is extensively used in Europe, while the multi-gap is used in America, and of late years the former is also very extensively used in connection with fluid arresters.

There are two kinds of fluid arresters used in America. In one the components are submerged in oil in a steel tank and known as an aluminium arrester. In the other the components are encased in an empty porcelain jar, and this is known as the electrolytic arrester. The principle of both is practically the same. It consists of a series of concentric aluminum pans placed one above the other, separated by an electrolite usually of borax solution.

In the aluminium arrester each cell is designed to operate normally at 300 volts, with a very small leakage current and with a permanent critical voltage of 420 volts, that is, the voltage at which the film opens and allows a free and heavy discharge, and a permanent critical value is thus 40 per cent above the normal operating voltage. Sufficient cells are placed in series on circuits of any given voltage to allow a normal voltage of 300 per cell. The arresters are connected permanently between line and ground and a multi-gap or horn-gap set at suitable value above line potential is inserted in series, and prevents the arrester from being subjected continuously to the line voltage. In this way leakage is prevented during normal operation and a longer life is assured.

Water-flow grounders have of late years very frequently been used on the continent of Europe, where they originated, and we find today a great number of types there. However, in America their use has not been advocated for the reason that the assumption of the failure of water supply points out, that the apparatus is inefficient. This objection is not quite justified, as the water may be drawn from the same supply from which the main turbines are fed, and as substations are usually located near a city, water from the city mains can be used. It is the practice in continental Europe to make use of the water which circulates through the cooling coils of the oil-transformers. Further, water from springs is oftentimes available. Water-flow grounders allow a continuous leakage, and one form of apparatus installed in connection with a 50,000-volt transmission system in Italy consists of a nozzle or jet of water (from a spring) playing against a baffle plate connected to the line. The stream of water is ⅜ inch in diameter, 28 inches long, and allows a leakage of 0.1 ampere. These are installed in addition to horn-gaps and choke coils to take care of light surges in a line and to maintain a uniform line pressure.

THE TWELVE PRINCIPLES OF EFFICIENCY.

By Harrington Emerson.

I. THE FIRST PRINCIPLE: CLEARLY DEFINED IDEALS.

Mr. Emerson's current series began in our June issue. The introductory article was a brilliant demonstration, from historic examples, of the power of certain principles of efficiency. His second paper showed the unsuitability of the ordinary organization for the introduction of these efficiency principles, and indicated the nature of the changes necessary to permit their application. He has now reached the "Twelve Principles" themselves, and will take up each one individually, beginning in this issue with "The First Principle: Clearly Defined Ideals."—THE EDITORS.

ASSUMING an organization adapted to their application, it will be found that efficiency principles, although all interrelated, all necessary to each other for highest results, nevertheless stand in a logical sequence.

The first principle is *a clearly defined ideal.*

In the earlier days of American manufacturing and transportation development, a century ago, a bright young journeyman who started out to manufacture some special line was very definitely aware of what he intended to make and how the work was to be done. He knew what he wanted. At the present time, in large plants men succeed to authority by transfer or by promotion and are very often without definite conceptions of the purposes for which the plant is working. Workers and foremen at the lower end of line organizations are so far from "The Little Father" or from the "Big Stick" who dictates all policies, who alone is responsible for organization, for delegation of power, and for supervision, that they are driven to create minor ideals and inspirations of their own, these being often at variance with the ideals of those above them. If all the ideals animating all the organization from top to bottom could be lined up so as to pull in the same straight line, the resultant would be a very powerful effort; but when these ideals pull in diverse directions, the resultant force may be insignificantly positive—may, in fact, be negative.

This condition of subsidiary deleterious and conflicting ideals is very common in all American plants, as well as great vagueness and uncertainty as to the major ideal, even among the higher officials, as

we shall try to show by various examples which could be duplicated by every experienced manager in the country.

A handy man in a railroad repair shop examined cylinders for cracks. These could sometimes be patched, but in other cases a new cylinder had to be ordered. A patch may cost $30, a new cylinder $600. The handy man swelled with pride when his recommendation for a new cylinder was heeded. He boasted to his wife and fellows of the confidence placed in him and the importance of his work. When in doubt, he reported always in favor of a new cylinder; and it was easier to accept his recommendation than to institute a separate revisional examination to be made by a man scarcely better qualified. The ideals of economy and promptness were submerged, and the conflicting ideal of individual aggrandizement substituted.

A large plant was filled with machinery for turning out work. Some of these machines were automatic and some hand-operated. The automatic had been introduced to lessen expenses and delays. The superintendent of the department was an ardent patriot and churchman; not a man was employed by him who was not recruited from his own nationality and church. He had installed piece rates, singularly inappropriate, since volume of work fluctuated suddenly between wide limits. When work fell off, instead of doing it all on the automatics, he shut these down, and had it all done by hand so as to give employment to his piece workers. His ideals were not *"best product in shortest time at least expense,"* but *"largest amount of employment and reward to fellow-countrymen and co-religionists."* This superintendent being unsupplied with ideals by the management, had created his own.

In another plant twenty-four men were working in the tool room. This was an excessive force, and the specialist in charge of tools allowed it gradually to shrink through resignations to eighteen men. Suddenly six new men reported for duty in the tool room, engaged by the general foreman. When the specialist interviewed him on the subject he stated: "My allowance for tool room is twenty-four men. If I get along without this number my allowance may be curtailed. Later when I need the men I may not be able to secure them. I propose to maintain the allowance whether there is work or not." It took a long time to convince this foreman:—

First, that twenty-four men were not needed.

Second, that if scheduled work made fifty men necessary he could have them.

Distorted ideals placed him in antagonism to the main purpose of the management.

In another plant, a general superintendent was very averse to any reduction of men below one thousand. He was anxious to turn out more work, was willing to curtail hours of the thousand employed, but to fall below one thousand, even though they voluntarily dropped out, seemed to him to be lowering his own rank since he had worked for years to reach the position of superintendency over a thousand men. Economy, efficiency, were all waived on account of a perverse ideal—personal pride.

The general superintendent of a plant employing twelve thousand mechanics was firmly convinced that the only way to turn out a large volume of work was to employ more men. He seemed to think that men could be piled into one side of the balance scale and volume of work into the other and that men would pull up the work by their gross weight. On one occasion he sent out an order that economy was not the object, but the production of output, and that the force was to be increased to the maximum. He ran up expenses $500,000 in five months and raised his unit costs far above what they had been, far above those of his competitors, far above what they retreated to when he was relieved of authority. A false numerical ideal worked at contrary purposes to true efficiency ideals.

The president of a great industrial corporation authorized standard-practice policies, then entered into contracts with clients on the basis of material, direct labor, and a percentage on direct labor. When it was pointed out to him that increased efficiency would mean fewer hours of direct labor, therefore less pay and less percentage for the same work, he promptly solved the difficulty by relieving the standard-practice advisor from the duty of offering further unpalatable advice, and by forbidding the application of efficiency methods to the shop in question.

In the early days of railroad construction all over the world, false conceptions and ideals greatly increased cost and left a legacy of inefficiency that centuries may not be long enough to obliterate.

The British engineers set up such high standards of grade, curvature, and double tracking, together with such low standards of clearance, as to double the initial cost of all British roads and curtail forever their capacity.

It is told of King Louis I of Bavaria that when he took his initial ride on a newly constructed rail line in his kingdom, he expressed

great disappointment that there was no tunnel, so the line was relocated and made to run through a hill.

Emperor Nicholas of Russia when deferentially asked by his engineers how the line was to be located between St. Petersburg and Moskow, took a ruler and pencil and ruled straight lines between the two cities. "That is the location, gentlemen!" It cost $337,000 a mile. Americans feel like smiling scoffingly at these mistakes, but was this arbitrary action any worse than that of a Secretary of the Navy who, without investigation and in spite of remonstrance by the naval board of construction, ordered the Texas built exactly according to the discordant purchased plans for two different vessels? No wonder the Texas was always a monstrosity!

What also shall we think of that American transcontinental road which having a water level between two points, 384 miles apart, deliberately abandoned the water level and put in 2,500 feet of mountain climbing and as many of descent between the same points, the officials after all failing to secure from a little western city the bonus for which they had sacrificed good location for all time.

In all these instances, from handy man with cracked cylinder to king, emperor, or knave ruling a railroad location, there is a definite ideal, however bad, consistently pursued; and when these ideals stand in dependent sequence, the result becomes exceedingly costly. The handy man orders a $600 cylinder instead of a $30 patch; his foreman, wishing to employ as many of his church members as possible, has the cylinder made on an inferior machine, with high piece rates; the general foreman fills the tool room with unnecessary men who become busy doing useless work at heavy expense for materials and overhead expense; the shop superintendent is content as he sees the men under him pass the one-thousand mark and joyfully acquiesces in the general superintendent's order to add fifty per cent to the force. Under this sequence, the making of an unnecessary $600 cylinder becomes almost a necessity and the handy man is promoted on account of his skill as a work provider. The 2,500 feet of mountain grade make many additional locomotives necessary, so there are many more opportunities to make new cylinders instead of patching old ones.

These are examples of the cankering effect of low or lateral ideals, but perhaps even greater loss results from vague ideals and from personal impulse.

At the siege of Sebastopol the officers at dinner in the ward room of a man-of-war were astounded to hear the big siege gun boom several times, with explosions of midshipman laughter afterwards. Each

firing of the gun cost $250. Investigation showed that bets were up between the middies as to which one could make a donkey move in the public square, and each was taking a shot in turn—with no damage to the donkey.

An engineer poured onto the ground a gallon of 40-cent oil in order to have the tinsmith solder a leak in a 15-cent can. A railroad track foreman and gang were recently seen burying under some ashes and dirt a 30-foot steel rail. It was less trouble to bury it than to pick it up and place it where it could be saved.

A young engineer in railroad service started out to spend some $750 for photographic apparatus, evidently laboring under the impression that if he only spent money enough he could overcome personal, meteorological, optical, and other limitations to good work.

The superintendent of a plant ordered a large automatic lathe to make crank pins from the solid bar. He had no ideals of his own, but vaguely felt that an automatic lathe ought to do cheaper work. When wire is cut into small screws it is the work that gives value, not the material; but in a crank pin it is the material that costs more than the work, and the cost of waste of new material on the automatic was greater than the total cost of scrap material, drop-forging, and turning by a boy under the old method.

The American mind is alert; men as individuals have been successful in proportion to their initiative; they have made great individual successes and also great individual failures.

It is not an accident that an American reporter was sent to find Livingston and that an American explorer forced his way to the North Pole. This reckless confidence in impulses, this reliance on individual initiative, is responsible for many failures and even if wild advice is not always followed, it is alarming that it can be so confidently offered.

At the time of the planning of the Grand Trunk Pacific Ry. a very brilliant young surveyor and railroad engineer wrote a thesis, urging that the gauge of this new line be made 30 feet, freight cars be made large enough to handle 1,000 tons, and all the buildings in the new villages, town and cities be erected in standard cement sections. Happily this young man's power was not commensurate with his imagination, but it is not always so. Not only do individuals make tremendous blunders, but corporate bodies make greater ones, because, not being composed of specialists, they are not able to curb the initiative of a strong-willed leader. As a consequence, clearly defined ideals are lacking and this relative lack will have to be pointed

out along general lines, using for illustration the seven wonders of the ancient world, the seven wonders of modern times, and in comparison with them seven great American enterprises.

There were seven ancient wonders of the world, each one of them a great work, nobly carried out. Even after the lapse of centuries, moderns of alien races can recognize and sympathize with the ideals that inspired these wonders. One of the tests of a definite ideal is that we can apprehend it even if we cannot always sympathize.

The oldest wonder-work of man is Egyptian—the great pyramid —at once a tomb and an astronomical instrument. The last ancient wonder was also Egyptian, the Pharos light house at Alexandria to direct the floating commerce of the old world to this great city. One of the modern wonder works is also Egyptian, the Suez Canal, so that through four milleniums Egypt has done a full share.

We can sympathize with the desire to have the largest and highest tomb ever constructed so that the bodies of king and of queen, preserved against decay, may lie in royal state until the time of resurrection. We can sympathize with the conception of the great light house, built by King Ptolemy Philadelphos—even with the trick of the architect Sostratos, who engraved his own name in the solid stone, but hid it by a layer of perishable cement in which he engraved the king's name.

Of the remaining five ancient wonders one was the hanging gardens of Babylon—a peculiarly appropriate glorification of irrigated tropical vegetation which has always been able to support the densest population, a power that may in time turn the tide of civilization backward from Canada, Northern Europe and Northern Asia, back from Argentine to tropical America, to tropical islands. The other four wonders were Greek, one of them the temple of Diana at Ephesus, one the tomb of King Mausolus erected by his widow, and two of them statues, the Colossus of Rhodes, spanning with outstretched legs the entrance to the harbor, and the master work of Pheidias, the gold-ivory statue of Jupiter at Olympia. There was faith or hope or love or beauty or civic pride in each of these seven wonders.

Of the seven modern wonder works of the world, not one is American. One of them, 400 years old, has its inspiration in religion—St. Peters at Rome, the largest church ever built; the second, 100 years old, is the greatest triumphal arch ever erected, commemorating the victories of the great conquerer Napoleon I; the other five are modern engineering works. It is typical of the changed ideal of the ages that only one of the ancient wonders was utilitarian, and

only one of the modern wonders is religious, five being very distinctly utilitarian; yet noble ideals gave them all birth.

Of the utilitarian works the Suez Canal easily comes first. It shortens the sea route from northern Europe to the Orient by 5,000 miles, between certain ports more than half. The canal was begun in 1859, estimated to cost $30,000,000 and to be finished in 1864. Its actual cost was $80,000,000 and it was opened in 1869. The ideal was realized, but none of the other eleven efficiency principles was thoroughly applied, most of them not at all; hence both the double time and trebled cost.

The next great engineering work was also French, the Eiffel tower, rising 1,000 feet into the air, at once the highest structure erected by man and the prototype of modern American steel construction, which as a matter of course followed when passenger elevators or lifts were made practical.

The third great wonder is the Firth of Forth bridge; cantilevers, similar to three pairs of great Eiffel towers, each pair joined at its base, each half stretching out horizontally 900 feet without end support. This bridge is massive in design because wind pressure is more dangerous than train load.

The fourth modern wonder is the St. Gotthard tunnel, 12 miles long, under the Alps. There was a Brenner railroad route over the Austrian Alps; a Mt. Cenis tunnel under the French Alps; but Italy, Switzerland and Germany combined to divert the century-old trade between south and north to a shorter new route, the key to the situation being the long tunnel, more than twice as long as any American railroad tunnel. This enterprise almost failed because the workmen, hygienically neglected, died in great numbers, killed by an intestinal parasite similar to the hookworm. The doctors ascribed the mortality to the work underground. The parasite has recently appeared in the United States, and may prove as serious a scourge as the hookworm.

The seventh and last of the modern wonders are the twin cousin ships, the Lusitania and the Mauretania, subsidized and designed to restore to Great Britain the blue ribbon of the sea. Of these seven wonders one belongs to Italy, one jointly to Italy and Switzerland, three belong to France, and two to Great Britain. An ideal definitely conceived in advance and tenaciously realized is manifest in each, and in most of them other efficiency principles are applied, in some only in embryonic vestiges, in others in advanced form—notably in the

two steamers, which as to cost, time of completion, and performance, realized expectations.

With these fourteen wonders, each with its own ideal, we may compare seven great American works of which none is religious, none a monument to beauty, while the utilitarian value of five of them is doubtful.

The Panama Canal, easily the costliest engineering work ever undertaken, is being prosecuted with vigor, and, thanks to the discovery of the yellow-fever mosquito and its suppression, a lock canal will be finished at a cost of about $600,000,000. Of twenty great minds selected by lot, no three would agree as to the ideal back of this great work. Mr. Roosevelt is entitled to speak with more authority than any one else, and his reasons for its building are also those of Goethe —that it was a work that some one would be tempted to undertake, some time, and that the United States was manifestly the proper party.

This is vague and uninspiring. The canal, in times of piping peace, when a navy is wanted for minor police duties only, ought indeed to lessen the need for a double fleet, one in each ocean; but those who favor a strong American navy, capable of holding its own against such a combination as Great Britain and Japan, scoff at the canal as a substitute for a strong navy. They know full well that in case of war with strong maritime powers either entrance to the canal could be made exceedingly dangerous by floating mines, by submarines, by aeroplanes; that it might be easy to destroy the canal itself either by damaging the locks, damaging the dam of the Chagres River, or sinking some vessel in the canal. If, for self-protection, it is imperative for the United States to maintain maritime strength both in the Atlantic and Pacific, it is not safe to risk the national honor and supremacy on any such device as a lock canal* trusting that it will work like a watch in war time.

The next in rank of great American engineering works are the new railroad terminals in the city of New York to cost about $300,000,000.

There are engineers who consider big passenger terminals a survival of the time when English coaches started from some central hostelry. Central terminals are perhaps a convenience to through passengers, with trunks; never to local passengers without trunks.

* From a military point of view, a tide-level canal would be in no better case. Its tremendous cuts, many protective works to control entering streams, tide locks at the Pacific, and long narrow channels would make it as vulnerable as the lock canal.—*Ed E. M.*

Passengers with trunks are very few, even in the fast through trains. Is it possible that these great terminals have been built to accommodate the few hundred passengers who have trunks? The 500,000 people who go out to and return from Coney Island on single hot summer holidays have not required great terminals; the million and a half of visitors handled on Chicago day at the Columbian Exposition did not require $100,000,000 terminals; the hundreds of thousands of passengers handled daily at 42d Street subway or at Brooklyn Bridge have not required palatial terminals. In fact, these great crowds would neither gather nor could they be handled if they had to assemble at an initial terminal, and debouch from an arriving terminal, both far from their homes. Passengers want to be picked up at their doors, landed at their doors, like letters; they do not want the plan, now obsolete even in villages, of delivering themselves like letters at the central post-office and collecting themselves like letters from the general delivery or *poste restante*.

Nothing is more convenient than the present plan of checking trunks from house to house in cities far apart, for a charge of one dollar, nothing more convenient than to drop from business office in New York into subway ten minutes before train departure and go to Seattle, Portland, San Francisco or Los Angeles, winter or summer, needing neither hat, top coat, nor umbrella since the traveler is never without cover, and if transfer has to be made it is more comfortable and easier to make it from a Denver train to the Santa Fe flyer at La Junta, Colorado, with its little station, than to make a similar change in a great New York, Chicago, Philadelphia, or Washington terminal. The great problem of city traffic is to secure distribution, to scatter foci, to dissolve congestion. Terminals of necessity create and increase congestion. Physically or financially, the ideals justifying these great terminal expenditures are not startingly apparent. Material and maintenance charges on these great works, if distributed to each incoming and outgoing trunk, or even to each going and coming through passenger, would give a striking modern illustration of Horace's dictum that no artist makes a mountain travail to bring forth a mouse.

The third great American enterprise is the New York barge canal. Railroad men, keenly alert as to its folly, assert that the money to be spent in the barge canal would build, equip, and operate without freight charges a railroad between Buffalo and the Hudson, capable of handling ten times as much freight in the course of a year. A barge canal built by the State seems a roundabout way of curbing

and limiting dreaded hypothetical railroad extortions, since the St. Lawrence River and Montreal route more or less fixes export rates from all American ports during the open season of navigation for canal and river.

The fourth great American projected undertaking is the improvement of internal waterways. It is assumed that the railroads are uncontrollable, although a single growl by the Interstate Commerce Commission causes a senseless decline of values in Wall Street. It is assumed by some that internal water transportation, subject to all the vague uncertainties of low water, flood, and frost, can be made so cheap as to bankrupt the railroads, although the Mississippi from St. Louis to the sea, open the year round, is paralleled by dividend-paying railroads. Railroad operation with its chronometer trains 99.97 per cent. reliable between terminals 1,000 miles apart has in this respect realized an exalted and noble ideal not to be undermined and curtailed by the return to obsolescent canals and river highways.

Our fifth great proposed expenditure is for an American Navy. If there had been no Maine there would have been no Spanish war, no war expenditure of one thousand million dollars, no Philippine problem making us an Eastern Asiatic power when we have not yet solved a dozen simple elementary problems at home, such as living wages for sweat-shop workers, lack of employment, civic honesty and cleanliness.

Every battleship five years old is obsolescent. Today and next year's development of flying machines may make every naval vessel as doomed as was chain and mail armor after the invention of gunpowder, as was the sailing corvette after the development of the steamship. Great Britain needs a navy and has kept up to date; has moreover coaling, repair and cable stations, indispensable to its effectiveness; but the value of great war navies to other nations—Germany, France, Russia, Italy, Argentina and the United States—has not yet been demonstrated; and to two of them, it has proved an added calamity in a losing war.

Every one of these five great works commits one of our American besetting industrial sins—over-equipment—due to mistrust of spiritual forces, reliance in material measures. It is almost assumed that if a mistake is gigantic enough it will become praiseworthy.

The sixth and seventh great American works are utilitarian, the subways in New York, and the elevator-served tall buildings everywhere. Even as to these, definite ideals have not been established and followed. Some of the tall buildings sacrifice utility to ornamen-

tation, others are painfully ugly but admirably adapted, while a third class are both ornamental and convenient. As to the subways, in view of the fact that they are an independent system connecting with no other road, it is a pity that they were not made with 6-foot gauge and 12-foot wide double-deck coaches, thus giving 150 per cent. greater seating capacity for the same length of platform and for an insignificantly greater initial expense.

It is not either the right or the privilege of the Efficiency Engineer to set up ideals of morality, goodness, or beauty, or to assume that his ideal of purpose is superior; but he has a right to expect that some definite and tangible ideal will be set up so that at the start its possible incompatability with one or more of the efficiency principles may be pointed out. The ideals underlying British railroad construction are very clear. No grades, no curves, no grade crossings, double tracks, great passenger terminals, and capitalization of all betterments. Although five of these ideals are not compatible with common sense and were not adopted at the start by either practical colonials or Americans, the Efficiency Engineer can accept an estimate of $375,000 a mile, the cost of British railroads, and aid in giving the best result possible for the money, since these ideals are not incompatible with any efficiency principle except common sense.

There is one great American railroad genius, always an idealist, who has risen to the commanding position in the railroad world because he had definite ideals. He states that a railroad company is to be managed to earn dividends, that expenses are by the train mile and receipts are by the ton mile. In twenty years, on these three precepts, he has built up a dominant railroad system. He has developed the country through which his road ran, and lowered rates, because this gave him more ton miles. He has reduced grades and curvatures and used heavy locomotives and long trains because this reduced the cost per train mile. He has reached out for Oriental traffic because this not only gave more ton miles, but equalized traffic, thus lessening ton-mile cost. To each one of the three ideals—dividends, low mile cost, large volume of traffic—each of the other eleven principles could be applied and in unusual measure have been applied by James J. Hill.

Another great railroad executive, J. W. Kendrick, regarded disagreements with labor as consuming time and energy, destructive to peace, loyalty, and harmony, and he therefore resolved to set up a high standard of discipline based on the Fair Deal made attractive by an Efficiency Reward. Not a breath of labor trouble has occurred

in six years in the departments to which these principles were applied, and the cost of each item of work has decreased, the standard of excellence has risen, the men have earned more money.

It is, howver, in industrial companies smaller than the great railroads that in a few cases high ideals have been adopted.

The ideals of one company are that its customers shall be treated with absolute fairness, that its employees shall be of higher skill and be better paid than those of neighboring competitors, and that they shall have permanence of employment. These ideals are an admirable foundation on which a very efficient organization has been built up, and while the managers have not consciously formulated and followed the eleven other efficiency principles, they are applying most of them.

The ideal of another company, to which they make their own profits subsidiary, is that their employees shall be able to lead wholesome New England village lives, the workers living near their homes, the fathers with leisure to retain leadership in their own families. An ideal of this kind is also an admirable foundation on which to build a highly efficient organization for, in corporations as in individuals, what is the profit of gaining the whole world if the soul is lost?

The president of an old and large plant near New York City stated with high-minded dignity the ideals under which he and his partners managed their business, not realizing how few managers had had time or opportunity to formulate such ideals, much less carry them into practice.

"We are not money-mad. We strive to be worthy sons of the worthy fathers who started this manufacturing business two generations ago. We wish to see our employees prosperous, well-paid, not overworked; we wish to surpass the world in the excellence of our product."

These are lofty, kindly, homely ideals and the efficiency engineer can frame this picture with all the other principles.

As to definite ideals, we could with profit learn from by-gone ages, although substituting other inspirations. Over one of the Greek Temples the words were carved "Know Thyself," for which we could substitute "Know the spirit rather than the externals of your business."

In the monasteries of a great religious order, every where was the inscription "Remember that death comes." For this we can substitute "Remember that we must endure." One great manager im-

pressed on his workmen that there were just two ways of permanently raising men's wages. To obtain more from the purchaser, or to lessen unit cost of product by eliminating wastes.

The vagueness, the uncertainty, the aimlessness that characterizes employees is but an infiltration of the vagueness, uncertainty, aimlessness, that characterizes employers. There can be no legitimate conflict between rails and locomotive, between locomotive and its engineer and its fireman, no legitimate conflict between engineer and despatcher, no conflict between despatcher and time-table which defines to a second the running time of a train going at extremist speed for a thousand miles or more.

If every manager would formulate his own ideals, promulgate them throughout his plant, post them everywhere, inoculate every official and every employee with them, industrial organizations could attain the same high degree of individual and aggregate excellence as a base-ball league. These ideals ought both specifically and by implication to include much that rational labor unions strive for; they ought as definitely to exclude ideals incompatible with efficiency.

For the manager endowed with common-sense but two courses are open. To set up his own ideals and reject all efficiency principles that do not accord with them, or to accept the organization and principles of efficiency and create correspondingly high ideals.

THE ETHICS OF ALLOWANCES FOR DEPRECIATION

By L. S. Randolph.

Depreciation has been and still is a topic of bitter controversy among accountants. Many of the arguments, however, like those of the old schoolmen, are mere cavillings over words, or dry mechanical propositions that wholly miss the sense and spirit of the subject. Professor Smith's discussion brushes away these quibbles over exact percentages and level or graded deductions, and goes to the heart of the matter—the essential factors involved, their operation, and the effect (upon all the interests concerned) of each of three possible general policies.—THE EDITORS.

THAT the problem of depreciation is as yet unsettled goes without saying; that certain phases of the question need discussion, particularly the ethical aspect of the question, is the excuse for this article.

The meaning attached to the word depreciation should be thoroughly understood if we are to form a proper and accurate conception of the question at issue. Depreciation is frequently made to include that fall in value due to the physical or material decay of a structure. It is true that physical decay might be considered as one element of depreciation; but it should be under the head of repairs or renewals, as all physical decay can be renewed or repaired so as to make the structure as good as new, and hence make the depreciation from that cause zero. Accuracy cannot be obtained by grouping together widely varying elements. Let us therefore formulate the following definitions:

Depreciation is the fall in value from any cause whatever which is unpreventable, the essential element being that the machine or structure becomes obsolete.

Renewals are the expenses incurred in replacing the decayed, over strained or broken members, the essential element being the replacing of a part or parts which are not expected to be renewed under ordinary operative conditions.

Repairs are the expenses incurred in replacing or refitting those parts which are worn out only, the essential element being that the

parts were expected to wear out and be replaced under the ordinary conditions of operation.

Depreciation may be due to one or more of the following causes:

Capacity too small for economic manufacture, as in the case of railway locomotives and cars; small cars not being able to compete with canals, whereas, large cars can.

Product superseded by product of other machines, as in the case of large steam hammers which have been superseded by hydraulic forging presses.

Demand for product ceasing, on account of change of fashion, as in the case of bicycles

Installation of more modern machinery, as in the case of the turret lathe and automatic machines superseding the ordinary lathe.

Introduction of new processes of manufacture, as in the case of steel superseding iron.

Legislation causing changes of economic condition, as in the case of the Dingley tariff closing the tin-plate mill of Wales.

Every manufacturer must meet these questions, as a new process may at any time be introduced which will produce the product at such figures as to drive him from the market.

Millions of dollars were invested in the bicycle business, magazines were filled with advertisements and hundreds of bicyclists were seen where none are seen now.

At the present time, enormous sums are being expended in the erection of plants for the manufacture of automobiles; and the only things, apparently, which will keep the business from following the course of the bicycle industry are that the motor vehicle has a wider commercial use than the bicycle and does not depend for its motive power upon the personal exertion of those who use it. It must be admitted that these are precarious arguments upon which to trust for a long productive life of any automobile plant.

A low rate of depreciation is simply an assumption that the productive life of the plant will be long.

A hydro-electric power plant is considered, generally, as typical of a long-lived plant, and yet it may at any time be met by the competition of a steam plant which can use its exhaust steam for heating in winter and refrigerating in summer, the income from the last two being more than sufficient to pay the operating expenses of the entire plant, leaving the power as a by-product to be sold for what it will bring. Under such conditions the hydroelectric plant would be-

come obsolete, its only salvation being that heating and refrigeration may not be able to supply the demand with *by-product* power.

The history of mechanical engineering is filled with instances of the rapid changes from one process or method to another; so rapid are these at times, and so uncertain are they, that any accurate estimate, if not impossible, would, to say the least, require prophetic powers.

Assuming that no accurate estimate can be made, we are confronted with the following alternatives:

1.—To make no allowance at all for depreciation.

2.—To attempt to make an accurate allowance.

3.—To make an allowance which will be on the safe side.

It is just here that the ethical side of the problem presents itself.

The investor purchasing the bonds, preferred stock, or, in fact, any of the securities of a corporation, may justly require:

1.—That he shall obtain his dividends or interest.

2.—That the property given as security for his investment shall be well taken care of.

3.—That upon the maturity of the securities, if they have a definite period of maturity, there shall be sufficient equities to meet his claim for the return of the money he invested.

It is manifest that any conservative investor would have declined to purchase had there been the slightest idea, on his part, that these points would not be carefully looked after.

It is to the investor in securities other than capital or common stock that the last item is peculiarly important. The common-stock holder is interested in the first two of these items only. In the third item, which covers the question of depreciation, his natural interest is contrary to that of the overlying-security holders, for what they do not receive will come to him in dividends, smaller depreciation allowance meaning larger dividends.

We are considering, therefore the relative rights of the common-stock holder and the overlying-security holders and must in fact sit in judgment on the claims of these two.

We can at once put aside any contention that no allowance at all shall be made for depreciation. The past history of commercial organizations is filled with the wrecks caused by failure to make an allowance for depreciation. The president of one of our large trunk lines remarked upon one occasion that "the principal cause of disastrous failures, from the corner grocery up, was that they carried

goods on their inventory at cost price long after they had become useless."

There is a record of one railroad which carried a large surplus besides paying heavy dividends. When the end came it was found that money had been borrowed from the surplus fund to replace obsolete and worn-out equipment (depreciation and renewals). Imagine what the conditions of affairs would have been, had the dividends been increased instead of passing the money to the surplus fund. Investors were buying this stock at a price based on the dividends *plus* the amount passed to the surplus fund, equivalent to some 15 per cent to 16 per cent on the stock, whereas the actual earnings, if a proper depreciation allowance had been made, would not have justified a dividend rate of 4 per cent.

If an attempt is made to predict accurately the productive life of a proposition we are apt to have results such as are described above; and while the results will not be so disastrous, nor be obtained every time, (as in the case where there is no allowance for depreciation) yet there will be very many similar cases—too many, in fact, for the best interests of good business. Wherever the productive life is over-estimated there will not be sufficient equities to satisfy the just and proper claims of security holders, and with the natural and altogether human tendency of the common-stock holder to err on the side of his own interests, this over-estimation will occur more frequently than not.

The third method—viz, that such a rate or allowance for depreciation should be used as will always give results which will be on the safe side—may be criticised as impracticable. The law of the special machine ("that no special machine can be economically installed unless the saving, on the work in sight, will pay for the machine installed, less its scrap value") may be said to be a special case where depreciation is, without any question, on the safe side.

When we apply this law to the question of depreciation, we observe at once that the phrase "work in sight" contains the gist of the matter. When we use as similes for this phrase "work of which we are absolutely sure," "work under contract," we understand the meaning of the phrase.

It may be argued that where the absence of an allowance for depreciation works an injury to the holders of overlying securities, an allowance which will always be on the safe side works an equal injury to the common-stock holder. This can readily be shown to be

untrue. In the first case, what should have been set aside for depreciation goes to the stock holder and cannot be recovered either in whole or in part. In the second case all that is set aside for depreciation goes first to satisfy the claims of the overlying-security holders, the remainder going to the common-stock holders who receive, in the end, all that should come to them; the only hardship being that they do not receive it as early as they should; they receive, however, interest on those amounts which would have come to them earlier had an accurate allowance for depreciation been made. Can we not therefore sum up these arguments as follows:

No depreciation allowance, or an assumption of infinite productive life, will ultimately deprive the overlying-security holders of the capital invested.

An attempt to determine the exact depreciation allowance will have the same effect in a large proportion of cases as no depreciation allowance at all, so far as the overlying-security holders are concerned.

With a depreciation allowance which is on the safe side, the overlying-security holders are fully protected and no hardship can be complained of by the common-stock holders.

Can it not then be safely stated that anything other than a safe allowance for depreciation or productive life is constructive fraud?

THE HEATING, VENTILATING AND AIR-CONDITIONING OF FACTORIES.

By Percival Robert Moses.

1. ITS ECONOMIC IMPORTANCE—SYSTEMS FOR TEMPERATURE CONTROL.

In two articles, of which this is the first, Mr. Moses reviews broadly the whole practice of air-conditioning, as to temperature, humidity, and purity. He outlines methods and the apparatus by which they are carried out, and presents foundational data on which good practice should be based.—THE EDITORS.

UNTIL recent years, attention to the ventilation and heating of factories was confined to the delivery of fresh air and the withdrawal of vitiated air, but the scope of this subject has been greatly enlarged and the modern ventilating plant takes care not only of the supply and withdrawal of air but the regulation of the quality of the air. The regulation of the quality includes the temperature control, the control of the humidity (i. e., per centage of moisture) and even the control of the chemical constitution. It involves the cleaning of the air, and frequently its sterilization. Ventilating apparatus is also used for the removal of dangerous dust or gases, and without this apparatus many manufacturing processes would be impossible or extremely dangerous.

The supply of fresh, clean, tempered air has been recognized for many years as a necessity, and its effect upon the character and quantity of the work turned out is beginning to be fully understood. The expense of providing pure, fresh air is not excessive if the system is competently designed, as will be explained later.

The necessity for ventilation arises from the fact that the average person breathing in air containing nearly 21 per cent of oxygen breathes out this air with only 16 per cent of oxygen. It becomes necessary, therefore, to introduce fresh oxygen, and the easiest way of introducing this fresh oxygen is to bring in extra supplies of air containing the oxygen. In order to allow this air to be brought in, it is necessary to provide means for withdrawing the vitiated air.

The oxygen breathed in by the person combines with the carbon in the blood and forms carbonic acid, and this carbonic acid in the form of gas mixes with the air in the room. On this account, the percentage of carbonic-acid gas found in a room is usually taken as the measure of the purity of the air. A word of caution is neces-

INSTALLATION OF 104 24-INCH "GLOBE" VENTILATORS, FACTORY OF THE LIBRARY BUREAU.

sary here, as in many cases the percentage of carbonic-acid gas will not be a measure of the purity of the air and of its fitness for breathing. Carbonic-acid gas itself is not dangerous in the quantities in which it is found; it might be present to ten times the amount usually allowed in good practice before it would become actually dangerous. But before this condition could be reached in ordinary workshops or factories the air would be unbreathable.

The usually accepted requirements for good ventilation are as follows:

Two thousand cubic feet of air per hour should be supplied for each operative; this air to be free from dust or other impurities and to be delivered at such a temperature as will maintain the temperature of the room between 60 and 70 degrees F., the humidity being maintained at 68 to 70 per cent relative humidity. The air should be delivered in such a manner as will not create an appreciable draft.

The result of such a supply will be indicated, in general, by a percentage of carbonic-acid gas of less than 9 parts in 10,000.

The necessity of providing ventilation in workshops and factories was strikingly shown by an investigation carried on by the Commissioner of Labor of New York State of the conditions existing in cigar and clothing factories, dye works, and other establishments. Instead of an allowable percentage of from 9 to 12 parts

of carbonic-acid gas in 10,000, the Commissioner found from 30 to 60 parts of carbonic-acid gas in this quantity of air, indicating an extreme condition of pollution. If it is remembered that all the clothing we wear, and the cigars we smoke, are manufactured in conditions of this kind, the importance of ventilation to the general public will be appreciated, and its importance to the workmen is far greater.

Besides the requirement of ventilation from the sanitary point of view, there are many special cases of ventilation:

In wood-working plants some means of withdrawing dust and sawdust is a necessity, because of danger from fire.

In newspaper establishments, where auto-plate machines are operated, the fumes must be withdrawn in a positive manner. These fumes arise from the melting of lead, the fire required for the melting, volatile acids used in the etching room, etc. The operating of modern crowded newspaper plants would be impossible without the removal of these gases.

In foundries, when the furnace is tapped and the moulds filled with molten metal, the whole place is filled with a heavy acrid smoke for which vent must be provided.

In salt mills, or blocks, as they are called, long vats sometimes hundreds of feet in length, containing steam coils and salt brine, fill the space above with moist vapor, and the steady removal of this vapor is not only essential from the point of view of the workmen, but from the point of view of the salt manufacturer, as unless it is removed the vapor will condense in the room and fall back into the salt vats, causing discoloration and a marked deterioration of the product.

In storage-battery manufacturing plants, or in buildings containing storage batteries, some provision for drawing off the sulphuric-acid fumes is a necessity, as otherwise the fumes would cut everything they come in contact with. I have seen all the copper on a panel board eaten away by the storage-battery fumes, and I have also seen places where the curtains and upholstery of an apartment were destroyed by the sulphuric-acid fumes creeping along the pipe openings provided for steam risers. The manufacture of storage batteries is very dangerous, as fumes are produced which cause decay of the gums, falling out of the teeth and, in time, death. The workmen have to wear masks to protect themselves, and the withdrawal of fumes is of utmost importance, as life depends upon it.

In potteries, it is absolutely essential for health that the dust be removed as made.

Further on in this article mention is made of textile and silk mills, where the percentage of moisture is of importance, and in printing establishments this is also true, as it has been found that where the air is too dry the paper sticks together and feeding becomes difficult.

In sugar mills very much the same conditions are met with in some parts of the process as in salt mills, but the amount of vapor is very much less, and on account of the method of evaporation employed, which is the multiple-effect method (enclosed vessels) the larger part of the evaporating process is carried on without open vapor.

In flour mills and starch mills very finely divided dust must be removed, as it is formed, if an explosion is to be averted. All apparatus, such as a direct-current electric motor, where contact may produce a spark, must be eliminated. One of my clients recently had his whole mill destroyed by the explosion of starch dust. So far as they knew, no sparks or open flames were permitted on the premises.

In the coal breakers, where the coal coming from the mines is graded and sorted, it is really heart-breaking to see small boys hardly out of their teens picking out the larger lumps, their faces begrimed with black coal soot, their nostrils and lungs full of the same stuff. Conditions such as these are absolutely unnecessary and if continued are a crime against society. I was informed by a doctor of the district that a large percentage of the boys and men employed around the coal breakers die of consumption and pneumonia, due mainly to the condition of their lungs from the coal dust.

In metal-working establishments, where buffing and polishing machines are used, there is a very fine emery dust which must be drawn away from the machinery as it is made, otherwise it will get into the lungs, causing irritation and a diseased condition.

In such factories as woodworking factories, where lacquering rooms are frequently found, the withdrawal of the lacquer vapor is essential for safety against fire.

These may be called the special requirements of ventilating plants, and there is hardly a business of manufacturing in which one or two special ventilating conditions are not present.

The main divisions of the ventilating problem are:

1.—Supply of fresh aid and withdrawal of vitiated air.

2.—Heating of this air and the heating of the building.

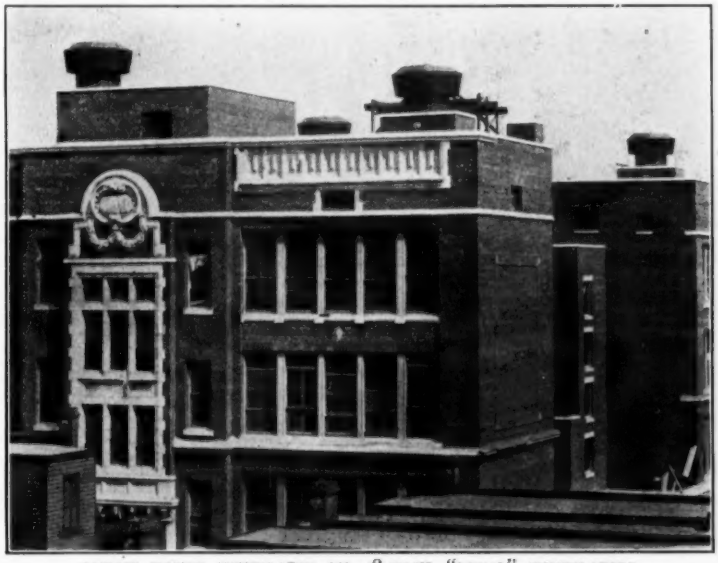
3.—Regulation of the quantity of the moisture in the air supplied and in the building.

4.—Cleansing of the air supplied.

5.—Cooling of the air supplied and of the building.

All these divisions are intimately inter-connected. It is not possible to regulate the humidity of the air without regulating its temperature, and it is not possible or economical to consider the ventilation of the building without taking into account the question of heating or cooling, as the case may be.

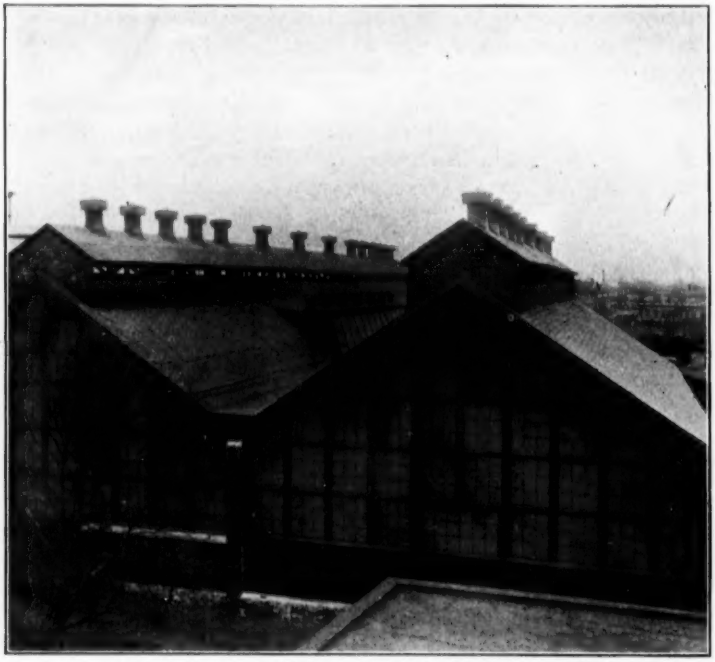
It will be well to consider first, briefly, the methods employed for supplying and withdrawing air and for tempering the supply. The most important method of ventilation is the natural method, because it is the one most frequently used for ordinary workshops and factories where regulation of the quality of the air is not so essential as the quantity. There are many months in the year when natural ventilation can be resorted to, and it is only when the question of heating, cooling, or humidity regulation come in that natural regulation fails fully to meet the conditions. Natural ventilating methods include the use of movable skylights, window ventilators, or roof ventilators of the Star, Pancoast or Pullman type. Air is allowed to come in through windows with special ventilators, and the usual method is to provide for heating it by radiators or coils around the walls under the window. For ordinary factories, where the number



SCHOOL-HOUSE VENTILATED BY 48-INCH "ROYAL" VENTILATORS.

of employees is not excessive, these systems give satisfactory results, except in very cold weather when all the windows are likely to be kept closed.

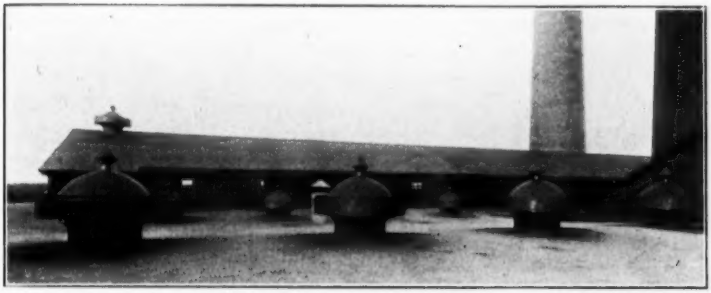
Where natural ventilation is contemplated, it is a good plan to provide some means for the admission of the air without causing direct draft upon the people working in front of the windows.



NATURAL VENTILATION OF MONITORS, EDGE-TOOL FACTORY OF THE FAYETTE R. PLUMB CO.
Thirty-five 20- and 30-in. "Royal" ventilators.

There are many devices for this purpose on the market, and all contemplate allowing the air to enter and be deflected in a vertical plane. The objection to natural ventilation is that the quality and quantity of the air cannot be regulated. Differences in the direction and pressure of the wind will vary the quantity of air delivered through a given opening, and in some cases will even cause an outflow of air.

With mechanical ventilation, the quality and quantity of the air may be regulated with a great degree of precision and the conditions in the workshop maintained fairly uniform. Every mechanical system must provide not only for the supply but for the withdrawal of



TWENTY-FOUR 48-INCH "GLOBE" VENTILATORS, POWER-HOUSE OF THE BOSTON ELEVATED RAILWAY.

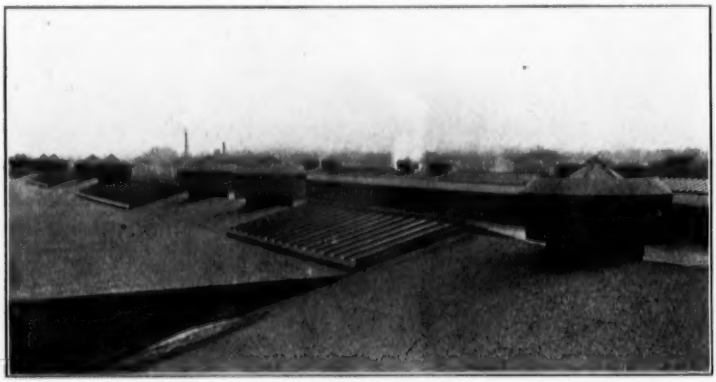
the air; one is useless without the other. A rather striking example of this was seen in a well-known newspaper building in New York City, where an elaborate ventilating system had been installed for the composing room. The original system provided merely for a supply system, delivering approximately 35,000 cubic feet per minute, and this quantity of air was sufficient to change the air in the composing room every 4 minutes, provided some means of withdrawing the foul air had been installed.

The conditions when examined were found to be quite bad, about 30 parts CO_2 in 10,000, notwithstanding this ventilating system. An exhaust system capable of withdrawing 41,000 cubic feet per minute was installed, with a special exhauster for the linotype machines which give off a quantity of fumes and heat. Since the installation of the exhaust system the carbonic-acid gas has been

NATURAL VENTILATION, RICHARDSON PAPER CO., LOCKLAND, OHIO.
Sixty-six Swartwout gravity-closing ventilators. Ohio Blower Co.

reduced to between 5 and 6 parts in 10,000, the outside being 4 parts in 10,000.

The folly of attempting to do things by halves was also shown in a lecture room. The plan had been prepared providing for an inlet, or, rather, an intake, of fresh air over coils, the air being distributed through the room by a number of openings underneath the seats. The air was to be withdrawn from the room by a large exhaust fan placed in one corner. The authorities decided to go ahead with the scheme, but only put in one-half; that is, they decided to

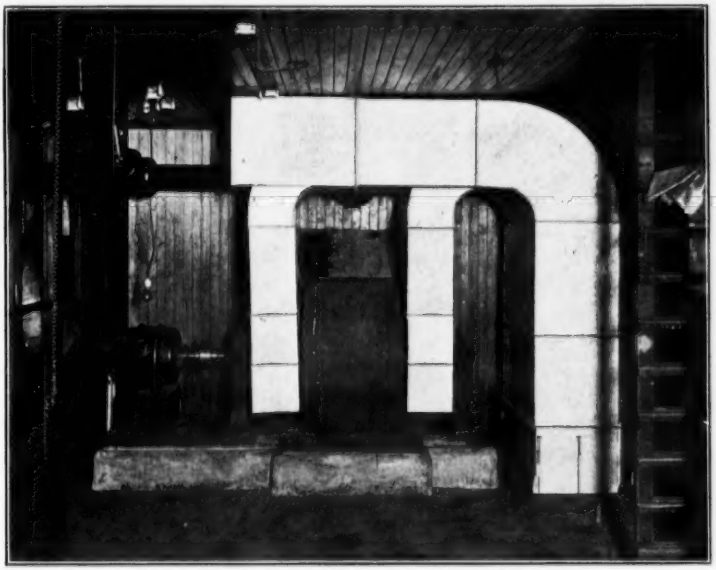


NATURAL VENTILATION, TRAIN SHED OF TOLEDO RAILWAY AND TERMINAL CO.
Seventeen 48-inch "Royal" ventilators.

put in the exhaust fan. This room was an entirely enclosed room, and during a lecture the only way air could be admitted to the room was through the windows, and as these windows were right alongside the students, any attempt to open the windows sufficiently to provide the necessary air caused dangerous draft, and naturally the apparatus could not work. One of my assistants went down with an anemometer and measured the velocity of the air going out from the fan with the door of the lecture room open, and with the door of the lecture room closed. The reason for the non-performance was clearly shown, as when the door was open and free admission of air allowed to the lecture room, the fan delivered a certain quantity of air. As soon as the door was closed, however, there was found to be a circulation of air right around the fan; that is, the air came in through the fan at the center and went out at the edges, so that insofar as the ventilation of the room was concerned it was doing no work.

The usual method of supplying air is to allow the air to be drawn over coils of pipe or cast-iron sections containing steam or

other heating medium. These sections are known as tempering coils and their object is to prevent the delivery of air below a stated temperature. This air, after preliminary heating, is then passed through a cleaning apparatus, and afterwards through a heating coil or stack where it is heated to the desired final temperature. The force causing the air to flow is produced by a rapidly revolving fan or blower. This blower is placed either between the air cleaner and the second heater or after leaving the last heater. Almost all blowers used for this purpose rely upon centrifugal force for the production of movement in the air; that is, the air is drawn in around the center of a rapidly revolving series of blades, which cause the air to revolve at a rapidity approximating that of the fan. The rapid revolution of the air produces centrifugal pressure and as soon as an opening is presented the air is discharged through the opening with a pressure depending upon the speed of revolution.



SQUIRREL-CAGE MULTIVANE VENTILATING FAN, RECENTLY INSTALLED IN THE PLANT OF THE WALTER BAKER CO.

Operated by 5-h. p. motor; double inlet. Draws in air, passes it over cooling coils to remove moisture, and delivers it into one of the cooling rooms. Massachusetts Fan Co.

There are different types of centrifugal fans, varying from the type known as the "cone" fan to the Sirocco or "multivane" type. The latter types are of recent development and rely not only upon centrifugal force but upon the actual peripheral velocity of the fan

blades to impart motion to the air. The blades of the Sirocco or "multivane" type of fan resemble the blades of a turbine, while the blades of the older type centrifugal fan are similar to the paddles of the paddle wheel of the old-type steamboat.

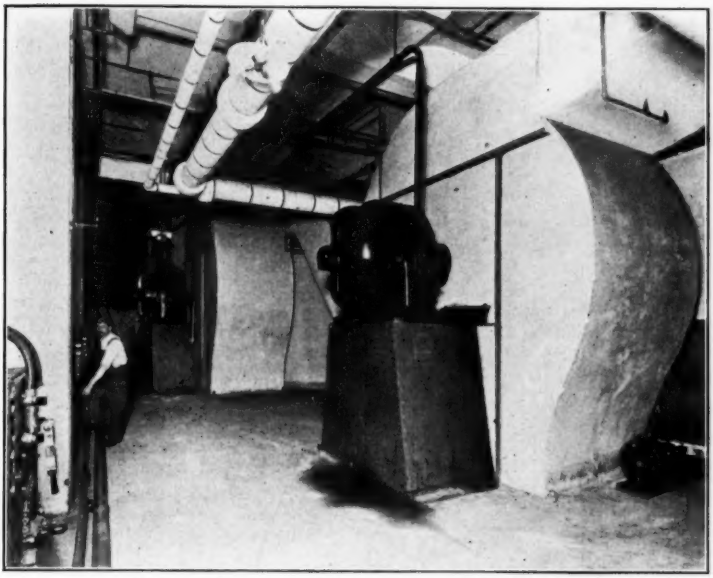
There is another type of fan used in which the discharge is into an open space. This is the "disc" type, which operates on the same principle as the propeller of a steamship.

Where any great frictional resistance is to be encountered, as in the discharge through long ducts, the "disc" or propeller type is not suitable, as its efficiency is very low and if any resistance is encountered the blades simply cut through the air without producing appreciable motion. The "disc" or propeller type fan finds its main us as an exhaust fan, drawing the air from rooms and discharging through protecting hoods to the outside air. For this purpose, they are preferable to the centrifugal type of fan, as they have a greater capacity per dollar of cost.

Where it is desired to regulate the humidity of the air, as in textile and similar mills, the regulation is effected by causing the air on its way to the fan to pass through a mist of water, completely saturating the air; or, the air is allowed to pass over a flat pan of water. In this water is a steam coil, to which steam is admitted or from which it is cut off as the amount of humidity in the air supplied varies. The admission of steam into the coil produces evaporation in the pan and causes more or less vapor to mix with the supply of air. The advantage of the first system is, that passing the air through a mist of water not only supplies humidity but also washes the air clean of dust and other impurities. Heretofore, dust has been removed from the air by a series of cheesecloth screens. These became foul in a very short while, and even in their prime condition were never able to clean air as efficiently as the water spray or shower.

The usual method of driving fans is either by electric motors, by steam engines, or directly from a countershaft used for some other purpose.

Where fans are used for ventilation only and not for ventilation combined with heating, the electrically driven fan is preferable on account of its simplicity and the ease with which it can be located wherever it is desired. It should be observed that where electricity is purchased from outside a different state of affairs exists than when the current is generated on the premises. If high-pressure steam is available for other purposes, it is usually found to be more economical to operate a steam-driven fan, using the exhaust steam



TWO OF THE VENTILATING FANS IN THE ALTMAN BUILDING.

from the fan engine to help heat the building or the feed water of the boilers. A striking example of failure to realize this fact came to my notice a few months ago in a model newspaper building, recently completed, which contained apparatus all of the highest efficiency individually; but failure to recognize interdependence of the parts caused the plant, as a whole, to be extremely inefficient. The ventilating fans in this building are electrically driven; high-pressure steam is manufactured for the purpose of operating elevator pumps and other pumps, and additional steam is taken from the boilers to heat the building. The ventilating fans are operating all day long and the air they receive is heated by steam coils. A knowledge of the steam requirements would have led to the choice of steam-driven fans, the exhaust from these steam engines being used to heat the building; thus, obtaining a double use of the steam and also of the labor. In fact, it may be safely stated that in this building no more fuel would be used in the winter if the fans were steam-driven, and a saving of at least $6 a day would be made in the electric bill. Where electric current is generated by a private plant on the premises, there is no economic objection to the electric-driven fan because the exhaust steam from the electric-generating plant can be used in the

building, and the combined efficiency of the engine, dynamo and motor is better than the efficiency of the ordinary steam engine used to drive fan blowers.

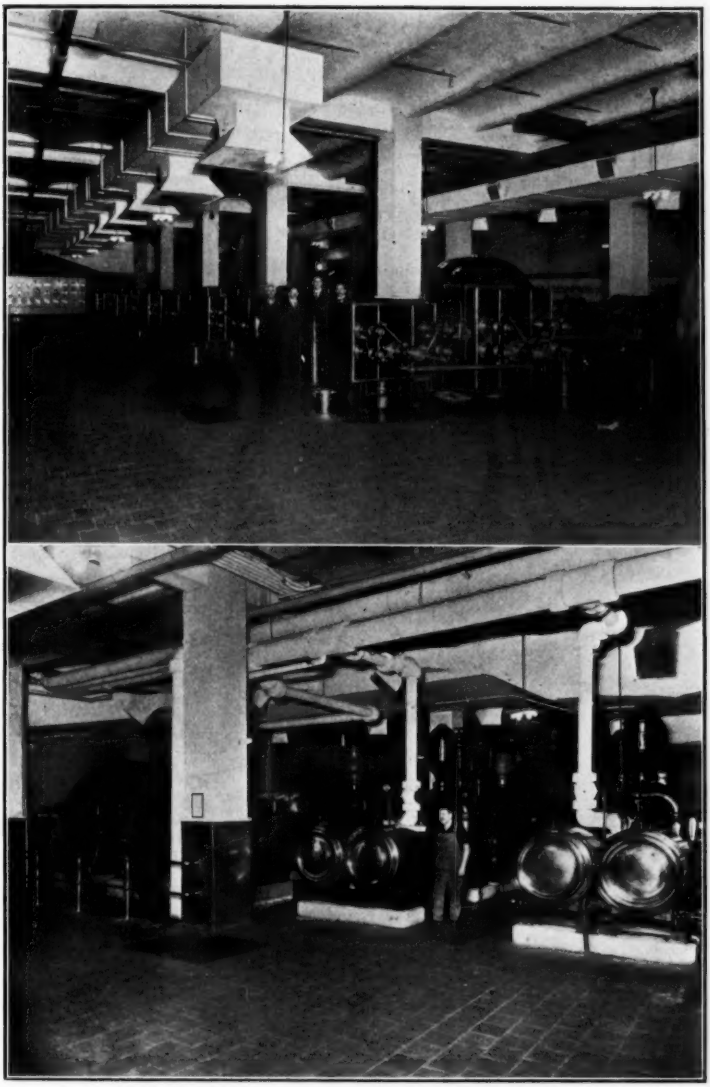
As between direct-connected, belted, and chain drive, the direct-connected motor is the most convenient and efficient, but the cost is greater because of the necessity of slow-speed motors. Belt or chain drive has the advantage of making any repairs to the motor easier, and with the belt drive speed adjustment is comparatively simple. By this I mean, that if it is found that the speed contemplated in the first place is too high, it can be readily reduced with belt-drive by changing the size of the pulley. (Speed regulation with electric drive is more difficult than with steam drive, on account of the fact that the power required by a fan blower varies with the cube of the speed.?) For example, a so-called 100-inch centrifugal type fan—i. e., housing 100-inch with a wheel 5 feet in diameter, operating at 190 revolutions per minute will give 9,540 cubic feet of air and requires 2¾ horse power. When operating at 380 revolutions per minute it will give 19,050 cubic feet of air and will require 13 1-3 horse power. At 537 revolutions per minute it will give 27,000 cubic feet of air and will require 36 horse power. Hence, if it is desired to provide for the reduction in the quantity of air delivered by a fan to 50 per cent of the rated quantity, it becomes necessary to provide for absorbing five-sixths of the power delivered by the motor and this involves great waste, while with a steam-driven fan the speed can be regulated readily by adjusting the opening of the throttle valve.

In most ventilating work, however, it is not usual to vary the speed of the fan by any great quantity, the amount of air supplied being adjusted by opening and closing of the dampers, the fan being arranged to operate at its maximum speed regularly.

Where it is necessary to exhaust gases, or hot air, or air carrying quantities of dust, the motor must be protected from contact with the air or gas taken out. If the fan be of the disc or cone type it becames necessary to detach the motor from the fan, while if the fan is of the centrifugal type the connection between motor and the fan must be made dust and gas proof.

MEDIUM FOR THE TRANSFER OF HEAT FROM THE COAL TO THE AIR.

The medium most generally employed for the transfer of heat from the coal to the air is steam. The reason for this is that in this the way the by-products of power manufacture—i. e., the exhaust from the steam engines—may be used; the automatic regulation of temperature is comparatively easy, and there is but little wear and tear to the apparatus. Hot water is also used for this purpose and



PARTS OF THE MECHANICAL INSTALLATION IN THE DEPARTMENT STORE OF B. ALTMAN & CO., N. Y., SHOWING THE VENTILATING PLANT.
Above is a general view of the engine room. Below, the elevator pumps.

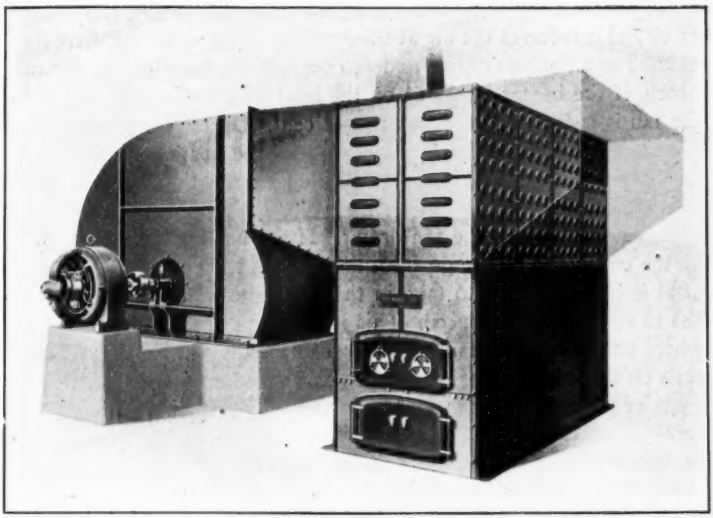
the advantage claimed is that the temperature of the water can be varied to meet the weather conditions. This is true, but substantially the same results can be obtained from steam coils by subdividing the heating surface so that the small portion may be used in mild weather and additional surface added in cold weather. The hot-water system has the disadvantage of large residual heating capacity, making quick regulation more difficult. There is also a greater tendency to wear and corrosion.

In one hot-water forced-circulation system the exhaust steam from the steam plant is used to heat the water required for the heating coils, and as the temperature of the water varies the degree of vacuum maintained on the engine varies. Equal results could be obtained with a steam plant by sub-dividing the steam plant into several units, one or more of the units being operated non-condensing during the winter's season when steam is required for heating; the load being divided up in such a manner that only sufficient load would be thrown on the non-condensing engine to provide for the necessary exhaust heating. Or, as is being done in several cases now, the plant may be divided into gas engines and steam engines, sufficient steam-engine power being installed to take care of the steam heating when operating non-condensing, while during the non-heating season and for all parts of the load not required for heating purposes, high-efficiency gas engines are used.

The use of direct furnaces for heating the air has also been advocated but, particularly in workshops and factories, the field for this type of apparatus is limited, partly because of the requirements for steam for power. I am inclined to think also that the wear and tear on this apparatus would be much greater than on steam apparatus, and there would be more difficulty in maintaining the equipment in prime condition.

The use of exhaust gases from gas engines is rapidly finding favor. In this system the exhaust gases from the engine pass through cast-iron heaters containing water. As these exhaust gases from the engine come out at about 1,000 degrees F., there is a considerable opportunity for saving by their utilization. It has been found in practice that about 2½ pounds of steam per hour can be obtained from a horse-power of gas engine by utilizing the waste gases and such part of the jacket water or water used for cooling the piston and piston rods as may be needed to supply the vaporizer.

The objection to using exhaust gases is that they contain a quantity of hydrogen and usually some sulphur, and if water is present there is a tendency to corrode. Hence, the use of cast iron.



HARRISON AERTUBE HEATER, FOR UTILIZING DIRECT OR WASTE HEAT BY TRANSMISSION THROUGH TUBES.

The air is propelled through the tubes by the fan, the hot gases passing around the tubes. Harrison Engineering Co.

If the Tait process is used for operating gas engines, the hydrogen practically disappears, as the producer gas used in the engine is practically carbonic monoxide and nitrogen. In this system, the exhaust gases from the gas engine are used in the producer instead of a steam blast, and as there is no danger of corrosion, any type of heater may be used; in fact, Mr. Tait recommends the use of an ordinary vertical tubular boiler, but my experience with such boilers would lead me to advise that if such a boiler is used it should be equipped with charcoal iron, copper, or brass tubes, not because of any corrosive action of the gases but because of the tendency to pitting and corrosion from the water inside of the boiler.

The use of a spray system of hot water for the preliminary heating of incoming air is rapidly finding favor as it not only heats the air but cleans it. The hot water should be used for tempering only, as if an attempt were made to do all the heating by a spray system and air anywhere near the saturation point of 150 degrees F. were delivered into a room and allowed to cool to 70 degrees, a great quantity of moisture would be precipitated.

Location of Heating Surface.

From the point of view of fan operation, the location of the heating surface on the discharge of the fan is the best, because with this

arrangement a fan of a stated size will discharge the greatest quantity of air, as it receives the air at the greatest density. The difference in volume of air at 32 degrees and 140 degrees is practically 25 per cent; hence, if the heater is placed on the inlet of the fan, the capacity of the fan is reduced very nearly 25 per cent. On the other hand, there are many conditions where the location of the heating surface on the discharge is not practicable. In placing the heating surface on the inlet, the air can be allowed to find its way through the coils into a chamber from which the fan draws. If the heating surface is placed on the outlet, the discharge from the fan has to be gradually enlarged until it is big enough to take in the whole heating surface and then has to be gradually reduced. This involves a great deal of space, and where this is of importance it becomes necessary to place the heating coils on the inlet. Where a building is divided up and different quantities of air and heat are to be supplied to different divisions, it becomes necessary to resort to re-heaters placed on the flues leading to the individual rooms, or to direct radiating surfaces placed in the rooms.

The coil placed on the inlet is usually termed the tempering coil, and it is important that this coil be diveded so that more or less may be used as the air outside decreases or increases in temperature. A division into three or four sections is usually sufficient. These sections should be hand-controlled and should be regulated in accordance with the weather condition outside. In addition to this hand-control, there should be automatic control. Automatic control on the tempering coil includes two functions. First, there is usually an automatic thermostat placed outdoors so that when the temperature falls below 32 degrees one of the coils is automatically thrown into the circuit to prevent freezing up. A second thermostat is placed in the discharge duct. This thermostat operates, whenever the temperature in the discharge duct falls below the desired quantity, to open up the steam supply and to close the by-pass damper, and when the temperature rises above that desired, it cuts off the steam supply and opens the by-pass damper. This insures a steady air temperature in the supply duct. If reheaters are required, these may be either hand-controlled or controlled by thermostats located in the rooms heated.

THE REVIVAL OF THE RECIPROCATING STEAM ENGINE.

By R. J. S. Pigott.

Mr. Pigott's theme is the very high economy in the production of power secured by the large piston engine combined with the low-pressure turbine. A preceding article, published in our July issue, dealt with thermal considerations and problems of design in getting up a good combination unit. This concluding paper discusses practical applications, either to new installations or revision of old reciprocating-engine plants by the addition of low-pressure turbines.—THE EDITORS.

THREE phases of low-pressure-turbine application are interesting as showing the various fields in which the steam engine is again pushed to the fore. Of course, since the engine-turbine combination is more efficient than either engine or turbine alone, no matter what the general conditions are, the thermal efficiency of any engine plant can be improved by the addition of low-pressure turbines. But the chief field is in adding to plants already installed, since the high first cost and consequently the high fixed charges against the combination unit militate against it as an initial installation for plants where the load factor is low. The three phases are:—large and economical engines, operating in a power house; medium size and less economical engines, in a manufacturing plant or small power plant; and engines to be designed and put on the market expressly for such low-pressure-turbine combination service.

In the case at 59th Street power station, which is such a notable example, the calculation of the situation was comparatively simple, and accurate to a more refined degree than would generally be the case, since a set of careful tests were available to show the relation between indicated water rate, actual water rate, and ratio of expansion, or, as Perry calls it, ratio of cut-off. The following discussion is intended to apply only to large-size compound condensing engines.

The first thing to do in computing the conditions resulting from a low-pressure-turbine installation is to establish a formula for variation of y, the missing water, with r, ratio of cut-off under the existing operating condition. This is done by plotting actual water rate per indicated horse power, indicated water rate, and ratio of cut-off,

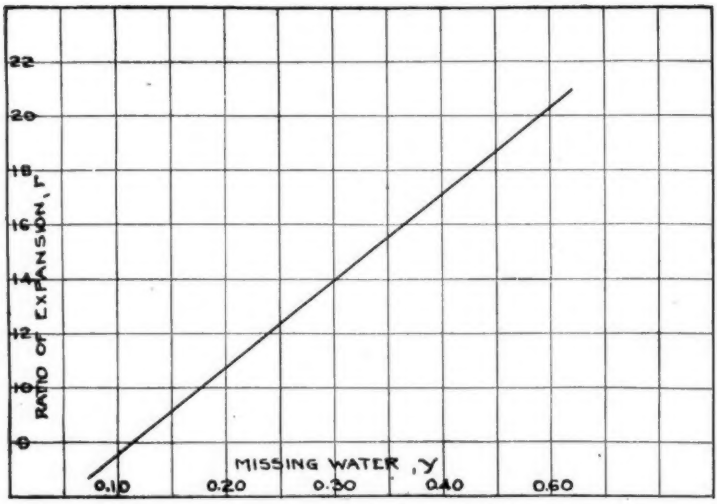


FIG. I. EVOLUTION OF FORMULA FOR MISSING WATER.

From test data:

$$y = \frac{\text{(Actual water per I. H. P. per hr.)—(Indicated water per I. H. P. per hr.)}}{\text{Indicated water per I. H. P. per hr.}}$$

$$r = \frac{\text{Total L. P. cylinder volume.}}{\text{H. P. cut-off volume.}}$$

Plotting the curve from the above, the equation of the line is $y = \beta r + a = .0317\, r - .137$.

against total indicated horse power, as shown in Figure 1, and substituting values in an equation of the form $y = a + \beta r$. This is for the engines at 59th Street plant, operating on 190 pounds steam at the throttle, about 5 degrees superheat, 28 inches vacuum, no reheaters or jackets, size 42 and 86 inches by 60 inches, double compound, speed 75 revolutions per minute, maximum rating 7,500 kilowatts. The formula only accounts for y at high-pressure cut-off. Now this missing water will only be affected at any given r by the pressure range in the high-pressure cylinder, for the same engine, other conditions of steam and speed, etc., being constant. Consequently, y will not be much altered by changing from condensing to non-condensing conditions, since the receiver pressure will be increased only by a few pounds. So that y as obtained above will be practically correct for the engine in both cases.

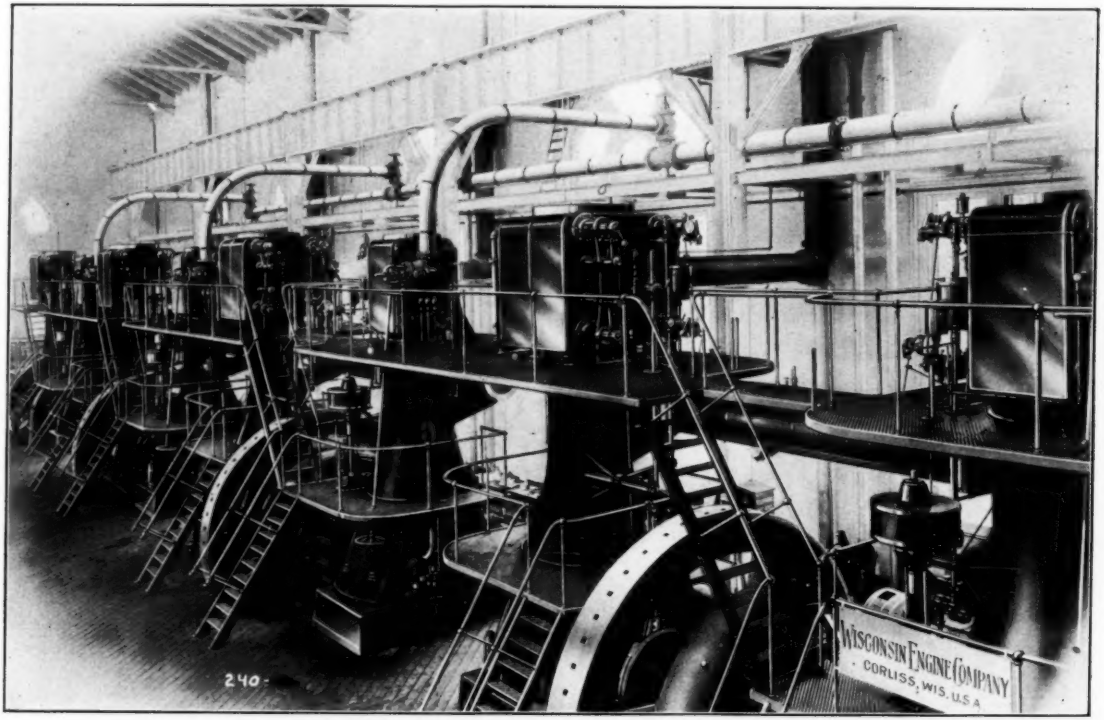
The next step is to assume indicator cards for the new conditions. There are two possible conditions under which the engine may be required to operate; with fixed back-pressure at all loads, correspond-

ing to variable nozzle-area admission to the low-pressure turbine; and with back-pressure varying with the load, corresponding to fixed nozzle-area admission to the turbine. In general, varying back-pressure operation has the advantage; no regulating device of any kind is necessary on the turbine inlet nozzles, nor any attention on the part of the engineer to this pressure; it is likely to be more economical than the fixed nozzle pressure (this point will be brought out more fully later); it gives better operating conditions on the engine, especially at light loads. On the other hand, with fixed nozzle pressure, the piping from engine to turbine is never under vacuum, thus lessening the risk of air leakage to spoil the turbine vacuum; but this point becomes unimportant if the piping is properly designed and erected. For the case of constant back-pressure, it may be possible to run the engines non-condensing at this pressure (about 16 to 20 pounds absolute) and get test data of water rates and cards. This is, of course, very desirable. But in case it cannot be done, the cards must be assumed for both cases; this has to be performed very carefully, making all losses, such as rounding of corners, pressure losses, and expansion and compression, as nearly as possible duplicates of the actual cards, for similar cut-offs. The receiver pressure must be adjusted by "cut and try" and the copious use of the planimeter till the indicated horse power of high and low is practically equal. The variable back-pressure cards must have this pressure established in such a way as to prevent looping in the low-pressure cards; it will be found impossible at light load to prevent very bad looping of both high- and low-pressure cards under constant nozzle pressure conditions, in any compound condensing engine, as the cylinder ratio is too large for non-condensing conditions. This looping is very hard on the engine and on the water rate, and is one of the objections to the constant back-pressure condition, as previously stated. In the case of Corliss geared engines, as in the 59th Street plant, the point of compression is invariable with load, so that the compression line can always be easily located; it is quite near the truth if this line is made hyperbolic, through the point of exhaust closure.

Having established a set of cards for at least four loads for both variable and constant back pressure, the r of each,

$$\frac{\text{(Total L.P. Volume)}}{\text{(Cut-off Volume, H.P.)}}$$

is measured, and the exact number of pounds of steam indicated at high-pressure cut-off and in high-pressure compression calculated. From these and the indicated horse power, obtained by plani-



A MODERN INSTALLATION OF CORLISS ENGINES, WASHINGTON NAVY YARD.

Four 20 and 38 by 36-in. vertical cross-compound engines, each driving a 500-kilowatt generator; 165-lb. pressure, 100 to 125 degrees superheat; believed to be developing an indicated horse power on 12 lbs. of steam, with 25 to 26 in. vacuum. Wisconsin Engine Co.

ASSUMED CARDS, VARIABLE BACK PRESSURE (=NOZZLE PRESSURE AT TURBINE.)																
No.	Total I.H.P.	H.P. I.H.P Only	Total K.W Load	Initial Press. Lbs. per sq. in. Absolute	Receiver Pr.	Back Press.	Ratio of Expansion r	Missing Water y	Indic. Water Rate / I.H.P/hr	Actual Water Rate / I.H.P/hr	Actual Water Rate / K.W.H.	Total Water Supplied Lbs/Hr	H.P. Exh. Qual.	Rec. Drums Lbs/Hr	L.P. Adm. Quality	L.P. Exh. Qual.	Lbs Dry Therm. at Exh.
1	5536	3020	4050	210	39.7	7.0	19.2	.474	12.0	17.7	25.9	105000	93.5	4700	98.0	92.6	92900
2	8192	4190	5590	"	46.0	10.0	12.8	.268	12.2	15.5	22.6	126600	92.1	7500	98.0	90.9	108300
3	9836	5080	6710	"	52.2	13.5	9.2	.156	13.6	16.0	23.4	157300	92.0	7900	97.0	90.0	134400
4	10752	5650	7370	"	58.5	18.0	7.0	.087	16.3	17.7	26.0	131100	92.4	8800	97.0	90.6	165100
5	11336	5810	7740	"	64.7	23.0	5.6	.033	18.9	19.5	28.6	221400	93.1	6400	96.0	90.6	194800
				CONSTANT BACK PRESSURE, 16 LBS. ABS.													
6	5676	2995	3875	210	64.7	16.0	12.8	.268	16.3	20.7	30.3	117400	93.3	5500	98.0	93.2	104300
7	8484	4220	5795	"	"	"	9.2	.156	15.6	18.0	26.4	152700	92.5	6300	97.0	91.0	132800
8	10540	5200	7130	"	"	"	7.0	.087	16.5	17.9	26.2	188500	92.5	8500	97.0	90.5	163700
9	12008	6000	8200	"	"	"	5.6	.033	17.9	18.5	27.0	221700	92.8	7100	96.0	90.3	193800

FIG. 2. TABLE OF DATA CALCULATED FROM ASSUMED CARDS AND FORMULA FOR y.
The columns set forth the data and results in about the order in which they appear in the calculations.

metering, the indicated water rate is obtained. Taking the formula for missing water, y, obtained from the original tests, and substituting the values of r from the assumed cards, the missing water fraction is obtained. Multiplying the indicated water rate at each load by $(1 + y)$ gives the actual water rate, from which the curve is plotted. The next thing needed is the quality of the exhaust steam, both of the high-pressure cylinder and of the low; the high-pressure exhaust quality is needed to find the probable trap water which is abstracted between the high- and low-pressure cylinders. The table, Figure 2, gives these values as computed for the 59th Street installation. The method of computing the quality of exhaust steam is simple and fairly accurate.

The heat contents of steam after passing through any cycle is equal to the original total heat, less the work done and the external losses. For the high-pressure cylinder, the external losses consist merely of radiation and conduction, which is less than 1 per cent. The work done in B.t.u. per hour is 2,545 x i.h.p. As an example, take assumed card No. 1 from the table; steam ½ per cent wet at 195 pounds absolute, total heat = 1,195 B.t.u. per pound, 105,000 pounds per hour; 1,195 x 105,000 = 125,475,000 B.t.u. supplied per hour; .01 x 125,475,000 = 1,255,000 radiation; 3,020 i.h.p. x 2,545 = 7,690,000 work done; 1,255,000 + 7,690,000 = 8,945,000. Sub-

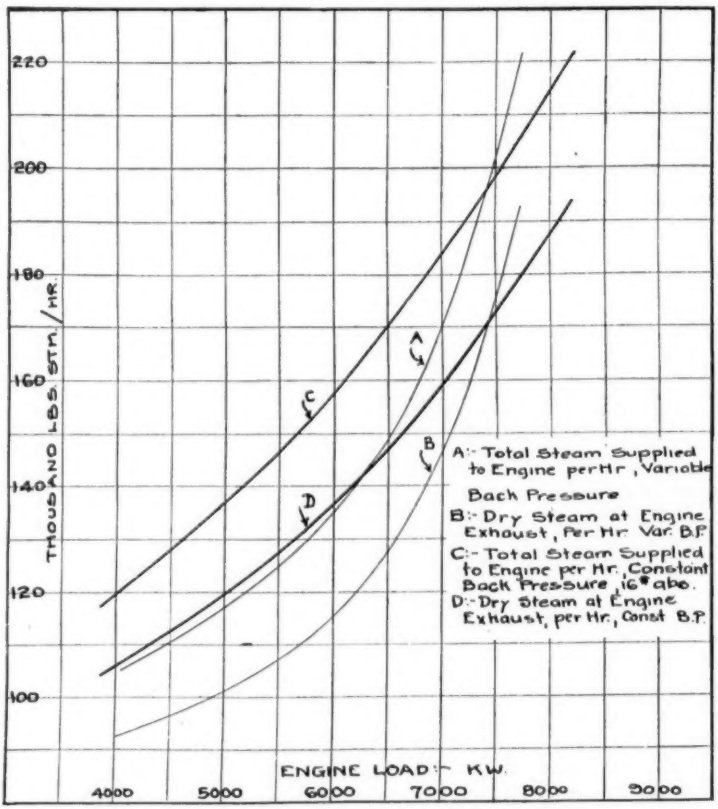


FIG. 3. VARIATION OF TOTAL STEAM SUPPLIED AND TOTAL DRY STEAM AVAILABLE FOR LOW-PRESSURE TURBINE, WITH ENGINE LOAD FOR VARIABLE AND CONSTANT BACK PRESSURES.

tracting 8,945,000 from 125,475,000 leaves 116,530,000, which divided by 105,000 gives 1,110 B.t.u. per pound.

At a receiver pressure of 39.7 pounds absolute, 1,110 B.t.u. per pound corresponds to a quality of 93.5, and similarly for the other loads.

The quality at low-pressure exhaust is obtained in the same manner, only the receiver drip heat must also be taken out; and the radiation and condition losses amount to nearly 2 per cent; using the same card as an example we have 1,195 × 105,000 = 125,500,000 B.t.u. per hour supplied; 2 × 125,475,000 = 2,510,000 radiation. It is probable that the receiver will send the steam to the low-pressure cylinder not better than 98 per cent quality, so we shall have going to the low-pressure cylinder 105,000 × (93.5 + 2) = 100,300 pounds, and 4,700 pounds drips removed. Receiver pressure 39.7 pounds absorption, heat of drips will be 236 B.t.u. per pound.

Then we have 4,700 × 236 = 1,110,000 B.t.u. per hour drip loss. Total i.h.p., 5,936 × 2,545 = 15,100,000 B.t.u. per hour + 1,110,000 + 2,510,000 = 18,720,000. 125,500,000 — 18,720,000 = 106,780,000 B.t.u. per hour ÷ 100,300 = 1,065 B.t.u. per pound.

At 7 pounds absolute back pressure, this corresponds to a quality of 92.6 per cent. Consequently. we shall have at this load, available for use in a low-pressure turbine, 100,500 × 92.6 = 92,900 pounds of dry steam at 7 pounds absolute pressure. Performing this for all the cards, we get curves of total dry steam available for low-pressure turbine at all loads, Figure 3.

For these conditions a turbine could be obtained with guaranteed water rates as shown in Figure 4. Picking out the loads of engine and turbine at any given total dry steam quantity, and dividing by the original total steam supplied, we get the new combined unit water rate, plotted in Figure 5. The turbine builders allow a 10 per cent margin in their guarantee, so the result shown by the curve could probably be bettered. In the case of the 59th Street installation, it was bettered by practically one pound per kilowatt hour in the unit water rate. Part of this was due to the fact that the loss of pressure between engine exhaust and turbine nozzle was actually only 0.65 pound, whereas the calculations and assumed cards were all based on a loss of 2 pounds. This meant an increase of engine power amounting to about 305 indicated horse power without increasing the steam supply.

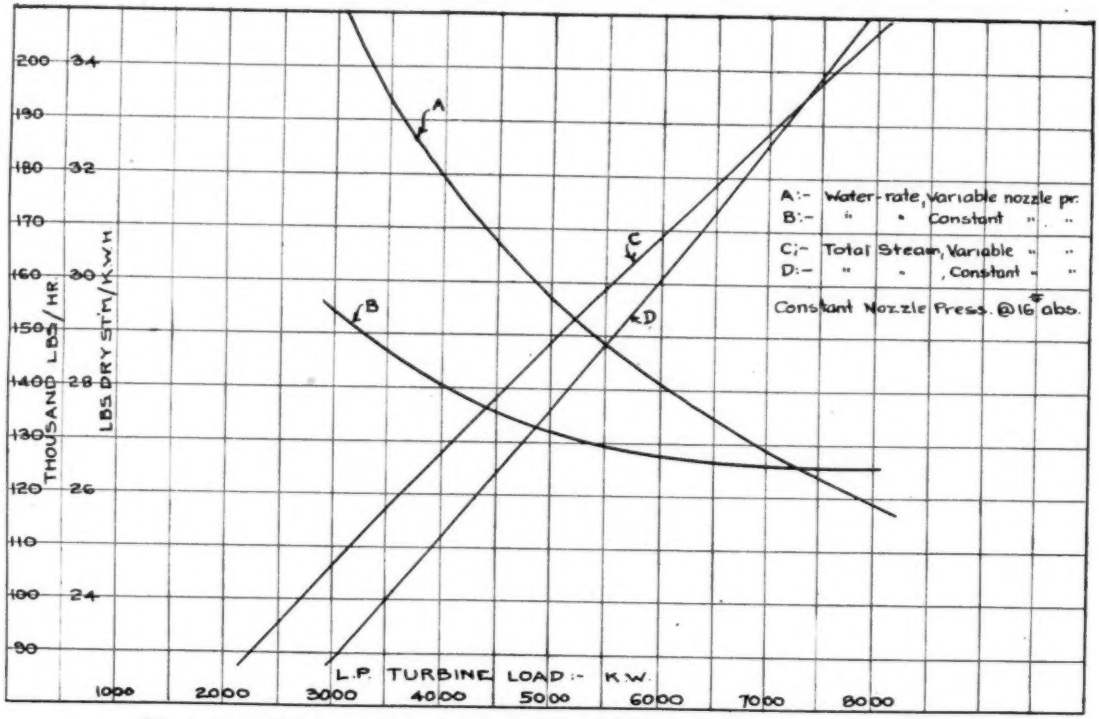


FIG. 4. VARIATION OF WATER RATE AND TOTAL DRY STEAM REQUIRED WITH TURBINE LOAD.

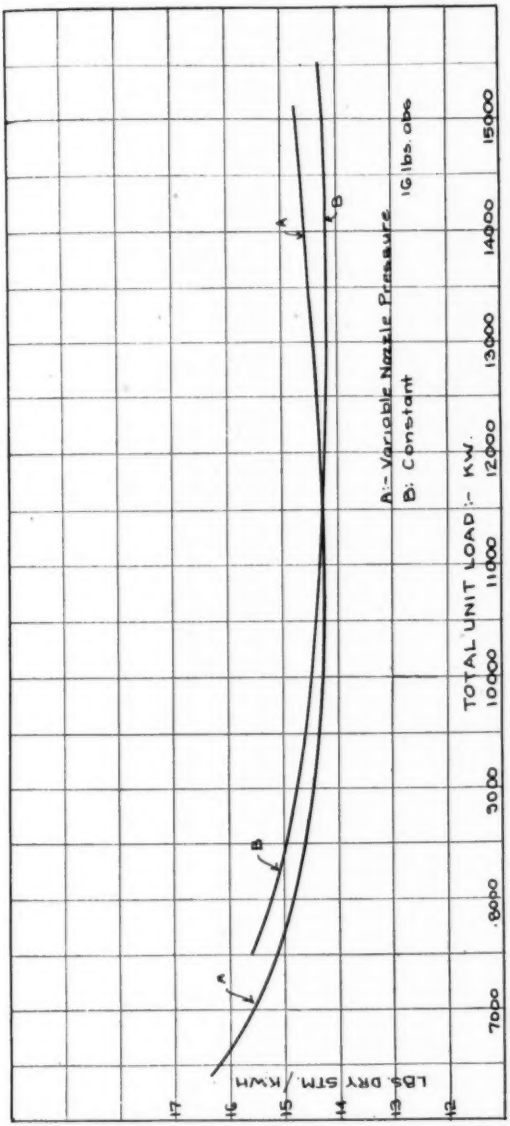


FIG. 5. COMBINED UNIT WATER RATE.

Some of this extra work shows its effect on the exhaust steam as moisture, but there is nevertheless quite a saving.

These curves show what may be done with a large, economical compound Corliss engine; but we need to know the possibilities of a smaller engine. As an example, let us take a 500 horse-power compound high-speed engine, about 18 x 36 x 16 inches, turning up about 250 r.p.m., piston valves, automatic governor. For brevity, we will take only the full rated load condition, supposing it to be the most economical load.

Let initial

steam be 190 pounds, about 1 per cent. wet, vacuum 27 inches, cut-off ½ stroke in high-pressure cylinder at 500 brake horse power, cylinder ratio about 4 to 1. We should get an indicated water rate of 14 pounds per horse power per hour; missing water.

$$y = 120\,\frac{1+r}{d\sqrt{np}} = 120\,\frac{1+\beta}{18\sqrt{250\times 195}} = .275.$$

Actual water rate will then be $1.275 \times 14 = 17.85$. With .90 mechanical efficiency this will give 19.83 pounds per brake horse power per hour = 27.4 pounds per kilowatt hour at 97 per cent generator efficiency.

Refiguring for non-condensing operation in conjunction with a low-pressure turbine, we should have about ¾ cut-off for full load, (500 brake horse power or 556 indicated horse power, or 352 kilowatts, back pressure 16 pounds absolute), r approximately 5.3.

$$\text{Taking } y = 120\,\frac{d\sqrt{np}}{1+r} \text{ we have } y = .192.$$

Indicated water rate approximately 18 pounds per horse power per hour; missing water at .192 and mechanical efficiency at .90, gives 21.5 pounds per indicated horse power per hour; actual water rate, or 23.9 pounds per brake horse power per hour, equivalent to 33.1 pounds per kilowatt hour at 97 per cent generator efficiency, 11,950 pounds total steam per hour.

Quality at exhaust will be 92.1 figured as previously, giving 11,010 pounds dry steam for turbine at 16 pounds absolute. A 400-kilowatt maximum rating machine would do a kilowatt hour on 31 pounds steam at this pressure; this would give 356 kilowatts additional output, with a unit water rate of 16.87 for a total output of 708 kilowatts.

There are hundreds of industrial plants where this increase of power and decrease of water rate, by way of low-pressure turbines, would be the easiest way out of a tight situation, for there are many advantages besides first cost and economy to be considered. In the majority of cases, increase of building is unnecessary for the addition of the turbines, saving an expenditure of possibly 35 per cent of the required outlay for machinery; the new auxiliaries are merely substituted for the old engine auxiliaries, occupying in general no more space (due to improved design in the latest machines). A high-pressure turbine would occupy additional space over the low-pressure machine, on account of adding another set of auxiliaries, and might force the erection of additional building, for it is

a fact that since the use of high-speed engines and turbines has become general for moderate powers, it is the boilers and auxiliaries that determine the space required. Roughly, the auxiliaries will occupy a flooring space one and one-half times as great as the unit served. And the additional piping required, (practically duplicating the engine equipment in that respect) would also be likely to make more building room necessary, in the case of the high-pressure turbine or engine added.

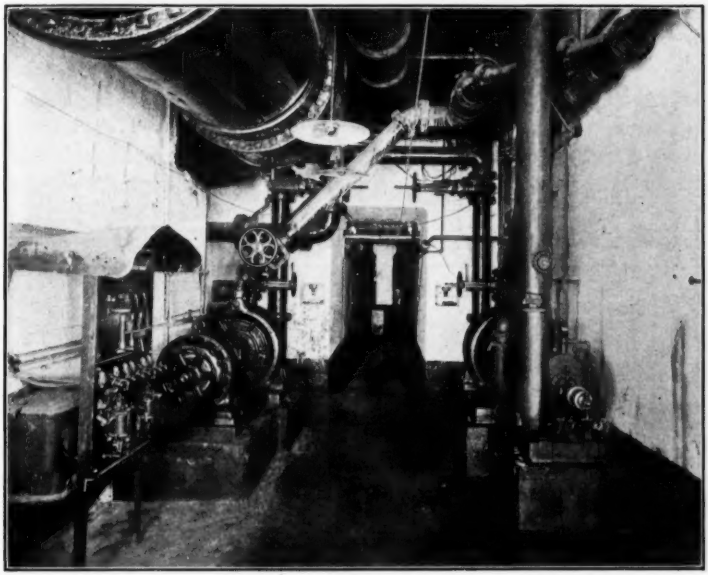


FIG. 6. HOT-WELL PUMPS FOR 15,000-KILOWATT ENGINE-TURBINE UNIT.
Only one pump is used; the other is reserve. Comparison with the 36-in. circulating-water pipe overhead shows the small size of these pumps.

The extra piping for a low-pressure turbine is comparatively small; for, although it is large size, it is made as short as possible by putting the turbine as close against the engine as may be. The advantages from these points of view are perfectly obvious and do not need elaborating—always remembering that the combined unit is *not* in general proposed for initial installation, but chiefly to add power to reciprocating plants already installed. To show more forcibly the influence that recent designs have had on the size of auxiliaries, Figure 6 shows the hot-well pumps used for removing

condensation from the condenser. They are two-stage turbine pumps, driven at 1,200 r.p.m., one by a 20 horse-power steam turbine, and the reserve pump by a motor. The whole pump could almost be put inside the circulating water pipe above it. This type of pump requires no attention but lubrication; and wear is imperceptible. The circulating pump engine is shown in Figure 7; the pump can just be seen beyond the engine. This outfit consists of a 500 horse-power American Ball Engine, angle compound, and a 30-inch Worthington centrifugal pump, and occupies a floor space of about 18 x 16 feet, which floor space was completely occupied by the vertical Corliss-driven reciprocating pump originally serving the engine; the original pump was 28 feet high, the new pump is but 10 feet. Of course, this is rather an extreme. At another plant, a 14 x 14-inch high-speed engine driving an 18-inch centrifugal pump is doing the same work as the old pump at 59th street, and occupies a floor space of 10 x 12 feet, being 8 feet high. These floor spaces include passage room around the machines. A

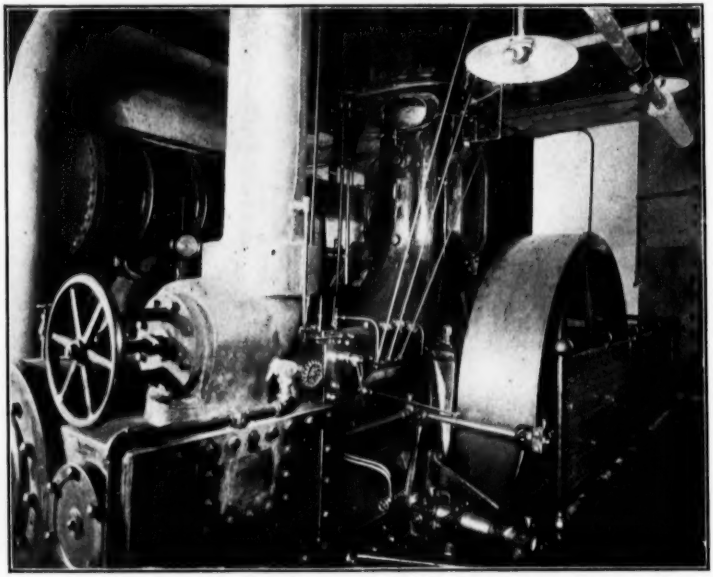


FIG. 7. CIRCULATING-WATER PUMP FOR 15,000-KILOWATT COMBINATION UNIT. The pump and engine occupy the same floor space and one-third the same height as the original 18-in. reciprocating pump supplying the engine only.

still smaller installation could be made if a turbine-driven pump were used; this, for the 30-inch size, would occupy a space of 19 by 8 feet and 6 feet high.

All the computations up to this point have been made on a basis of saturated steam supplied to the engine. But there is one easy way of materially adding to the efficiency—by superheating. Nearly all plants would stand a moderate degree of superheat, say not more than 100 per cent, without trouble from cast-iron fittings or lubrication. Another point in favor of moderate superheat, or what amounts to the same thing, reheating, is that the low-pressure turbine suffers very materially in water rate if fed with wet steam, and it is a very difficult matter to remove the moisture from the engine exhaust and it is practically impossible to remove the last 1 per cent without reheating. The saving is practically all made in the first 75 per cent of superheat at the engine throttle. The saving can be calculated approximately. As soon as enough superheat has been added, so that the steam is always dry in the cylinder, that portion of the missing water which is condensation will practically disappear; for as soon as the cylinder is entirely dry, the surface resistance to transmission of heat is enormously increased, so that very little heat transmission per cycle occurs. This removes the chief loss from moisture. The leakage past valves and piston is changed from water leakage to steam leakage, under superheat, consequently the leakage is cut down to about 1/10 or 1/20 of the leak with saturated steam (since the viscosity of water is so low at temperatures above 212 degrees, and the specific volume of water is so much less than that of steam). So that of the water missing with saturated-steam condition there would be only 8 to 10 per cent with superheated steam.

Refiguring one case of the 15,000 kilowatt engine-turbine combination—No. 3, Figure 2—for superheated steam, 150 degrees superheat at throttle, all other conditions the same.

$y = .156 \times .10 = .016$ under superheat.

Actual water rate $13.6 \times 1.016 \times \frac{2.19}{2.47} = 12.3$.

2.19 = sp. vol. sat. steam at 210 pounds.

2.47 = sp. vol. super. steam at 210 pounds.

B.t.u. supplied = $12.3 \times 9,836 \times 1,259 = 152,000,000$ per hour.

Radiation, 1 per cent, 1,520,000 B.t.u. per hour.

Horse power work, $\frac{12,940,000}{14,461,000}$ B.t.u. per hour.

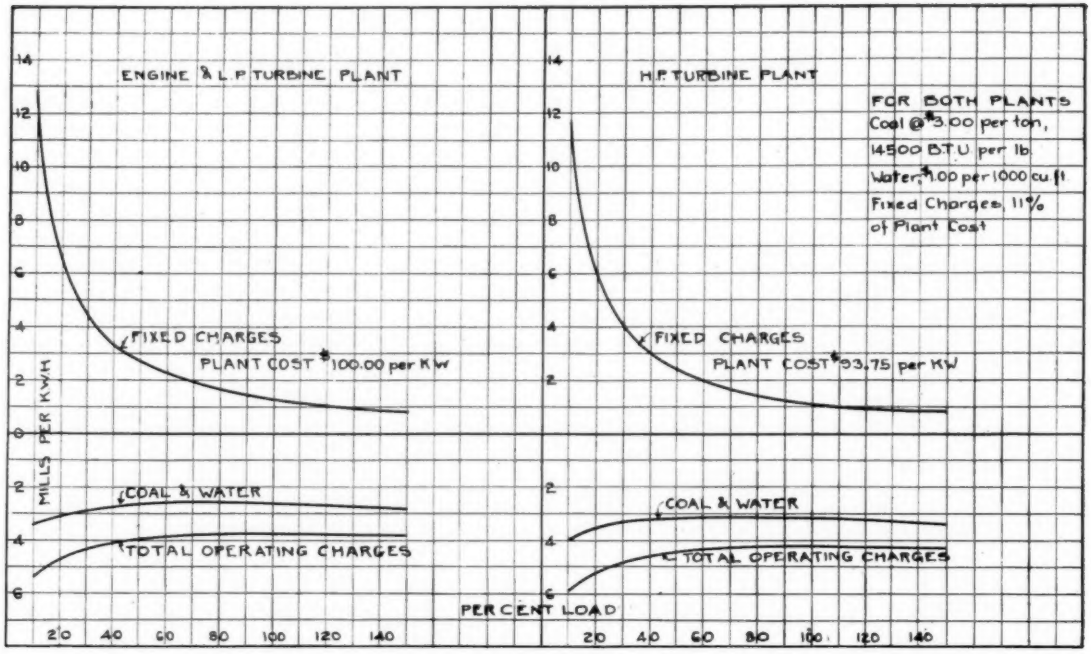


FIG. 8. COST OF POWER FROM HIGH-PRESSURE TURBINE INSTALLATION AND ENGINE-TURBINE INSTALLATION.
Courtesy of Mr. H. G. Stott.

$$\text{Leaving } \frac{137{,}640{,}000}{121{,}000} = 1{,}140 \text{ B.t.u. per pound at 52.2 absolute.}$$

This gives a quality of 96.5. Reheating to 100 degrees superheat again requires $(1{,}225 - 1{,}140) \times 121{,}000 = 10{,}280{,}000$ B.t.u., or the equivalent of 8,180 pounds live steam, considering the hot water drained away from the reheater coils as recovered for feed water, since it is clean.

This leaves a quality at low-pressure exhaust of 96 per cent, figured as before. The turbine will have available 116,200 pounds of dry steam, which will be used at about the same water rate as the amount available with saturated steam, since the pressure is the same, giving an output of about 4,200 kilowatts on the turbine. The resulting unit water rate is, therefore,

$$\frac{121{,}000 + 8{,}180}{6{,}710 + 4{,}200} = 11.9 \text{ pounds per kilowatt hour.}$$

This amounts to a saving of 12 per cent. But all of these calculations on saving by superheat are very uncertain.

The point which remains to be considered is alteration of design of the engine to suit the requirements of operation as the high-pressure member of a combination unit, and is summed up in four points: reduction of condensation missing water; reduction of leakage; higher speeds in large sizes; and better lubrication.

Superheat will eliminate the condensation and most of the leakage; poppet valves are practically entirely tight, and are the only valve suited for superheat; it follows that the poppet valve in some form must become the standard valve. New piston packings will have to be designed, probably with more parts and more separate narrow sliding surfaces—multiple rings, perhaps. Higher speeds point to single-acting engines, although Americans have never looked upon these with much favor. The Germans have been very successful with their engines, getting much better water rates in smaller sizes. Their favorite type is poppet-valved throughout, either horizontal or vertical, and valves driven by a geared lay shaft. In England several builders (notably Willans) make very successful single-acting engines with very high speeds, and very good water rates. It looks as if the trend would be toward some hybrid design, made up of the best features of both German and English types. The only field in which the large reciprocating engine is solidly entrenched, and for which it must now be designed, is for high-pressure, non-condensing conditions, either where exhaust steam is used for

heat or industrial purposes, or for use with low-pressure turbines. There are some cases, chiefly in manufacturing plants, and also in power plants, where the load factor is over 50 per cent, in which an initial installation of high-pressure engines and low-pressure turbines would be the cheapest way to produce power, because the low operating cost more than offsets the high first cost. Total power cost is made up of two portions; fixed charges and operating charges.

Figure 8 shows cost of power from a high-pressure turbine installation and an engine-turbine combination as presented in a paper before the American Institute of Electrical Engineers by Mr. H. G. Stott, whose kind permission has allowed the use of the curves in this connection. This shows clearly how the increasing influence of fixed charges at low load factor offsets the saving in coal and water by the more economical combination unit. The arrangement of the curves allows of the use of any operating charge as altered by different costs of coal and water, with the same plant cost. With the condition assumed, at 35 per cent load factor, the power cost from both types of plant is the same. Above this point, the combination type is cheaper; and below, the turbine alone is cheaper.

COSTS OF MACHINE-TOOL OPERATIONS IN STEAM-ENGINE MANUFACTURING.

By Wm. O. Webber.

Mr. Webber's cost data are gathered within recent years from his own experience in the management of machinery-building works in the eastern United States. Careful reconsideration of the figures, and comparison with like costs in other shops, shows that any improvement in tools since Mr. Webber's tables were compiled is about offset by rise in wages, so the data correctly represent average present performances. Special interest attaches to Mr. Webber's testimony on pages 733 *et seq.* to the improved efficiency brought about by attention to some of the "Twelve Principles" laid down by Harrington Emerson in the series of articles now appearing elsewhere in these pages.—THE EDITORS.

AN intimate and personal knowledge of the different processes and methods of doing machine-tool work is very essential to the evolution of a proper system of piece and premium work. It is a fatal mistake to make a price so large at first as to necessitate or even to tempt a cutting down at some later period, as this always makes trouble and creates a feeling of uncertainty and suspicion on the part of the employee. It is a great deal better to make the first price so small that you practically have to guarantee the average day's wages for that class of work, in order to get the employee to make a strenuous effort to better it.

In making such prices it is a fatal mistake also to jump at a conclusion or to guess at the price; the more intelligent way is mentally and personally to go through the several forms of operations upon the identical piece of work under question, and to estimate carefully the time necessary to set the piece in the machine, to calculate the square inches of surface to be machined and the number of cuts required to complete the machining, the feed which can be carried for the respective cuts, and the time necessary to accomplish the given results, and then to convert these data into an average cost per hour for the kind of labor required.

Some results obtained experimentally in various classes of metal-cutting work are noted in the accompanying tables. The first of these tables, on page 730, shows machining costs on connecting rods for small, simple horizontal engines, where the work was done in lots of 20 parts each. Some interesting data were obtained as to the relative cost of forging and machining. For instance, these connecting rods

COST OF MAKING CONNECTING RODS.

Size of Engine.	Forging, Per Piece.	Turning (each) 1 Lathe.	Turning (each) 2 Lathes.	Planing. Fitting.	Planing. Finishing.	Slotting Straps, per Pair.	Planing Straps, per Pair.	Turning Brasses, per Pair.	Assembling per Set of Five.
8 x 12	$1.15	$0.38	$0.26	$1.00	$1.30	$0.21	$0.25	$0.25	$8.50
9 x 12	1.25	0.40	0.27	1.15	1.85	0.21	0.25	0.25	9.00
10 x 12	1.35	0.40	0.27	1.15	1.85	0.23	0.30	0.27	9.80
10 x 15	1.45	0.45	0.32	1.30	2.20	0.26	0.30	0.27	11.20
11 x 15	1.60	0.50	0.35	1.30	2.20	0.27	0.33	0.30	12.25
12 x 16	2.00	0.55	0.36	1.50	2.50	0.44	0.35	0.33	13.80
14 x 16	2.40	0.60	0.42	1.75	2.75	0.50	0.35	0.60	15.50

COST OF MACHINE-TOOL LABOR IN BUILDING CENTRE-CRANK ENGINES.

Size.	Lathe.	Drill.	Planer.	Vise.	Slotter.	Shaper.	Bolt Cutter.	Black-smith.	Total Hours.	Value for Twenty Engines.	For one Engine.
8 x 12	$104.56	$31.44	$40.14	$240.57	$11.87	$14.20	$4.22	$29.25	2,405.00	$537.57	$26.83
9 x 12	116.88	30.18	54.09	279.81	14.50	16.66	4.22	31.50	2,813.00	617.05	30.85
10 x 12	122.40	51.42	61.83	283.05	12.87	11.98	4.55	31.50	3,090.00	655.71	31.25
10 x 15	138.56	48.12	59.31	283.59	14.00	17.08	5.20	33.75	3,365.5	684.84	34.24
11 x 15	159.20	51.00	65.61	331.56	12.87	18.61	5.20	33.75	3,974.35	695.85	34.79
12 x 16	174.88	76.68	72.36	350.64	21.25	46.15	5.52	36	4,707.50	807.40	40.37
13 x 16	168.80	54.60	82.98	405.27	23.25	22.27	5.52	38.25	4,530.00	906.00	45.30
14 x 16	216.16	88.24	94.04	450.18	25.00	49.46	5.84	40.50	5,350.00	1,070.00	53.50

PERCENTAGES OF LABOR AND COSTS. CENTRE-CRANK ENGINES.

8 x 12	21.90	6.60	8.45	50.5	2.48	2.98	0.88	6.10—99.89
10 x 12	21.00	8.90	10.70	48.7	2.21	2.06	0.78	5.42—99.77
12 x 16	22.20	9.80	9.20	44.7	2.71	5.90	0.70	4.60—99.81
Average	21.70	8.43	9.45	47.9	2.46	3.64	0.75	5.37—99.76

This table shows the percentage of labor and costs for three different sizes of these engines, from which it will be seen that the percentages for the different classes of work are very uniform. This is also true of side crank engines of the same general type with hooded bed and overhung cylinders.

were made largely from round iron with ends upset to form the rectangular parts to which the brasses and straps were attached, the rods being then turned a double taper from the center, reducing toward each end. Forging at the price given (which included the straps and keys for each size rod) left a surplus of stock to be turned off in the lathe between the square ends, or (in shop parlance) the "stub ends." It was therefore determined to forge the rods more closely to the finished size; but the saving in turning was more than made up in the extra cost of blacksmithing, lathe work costing only about 19 cents an hour as against the cost of 45 cents per hour for blacksmith, helper, and fire.

Some more interesting figures were obtained in different methods of doing the work, that is machining straps on the shaper as against doing the same work on a planer, and milling brasses on a milling machine, as against doing the same work on a shaper.

It will be noted also that there are two prices given for lathe work, the price for two lathes being cheaper than that for one lathe. In this latter case the workmen would rough out on the one lathe and finish on the second. This difference of price in connection with the use of more than one tool is emphasized in the turning of crank shafts for these same centre-crank engines for instance.

In roughing out the workmen could easily run two lathes or in finishing it paid him to hire an apprentice at a fixed rate to assist him in running the three lathes.

COSTS OF OPERATIONS ON CENTRE-CRANK SHAFTS.

	Turning (each)			Turning	Slotting	Key
Size.	1 Lathe.	2 Lathes.	3 Lathes.	Discs.	Discs.	Seating.
8 x 12	$1.80	$1.15	$1.00	$0.35	$0.31	$0.20
9 x 12	1.80	1.15	1.00	0.35	0.31	0.23
10 x 12	2.00	1.40	1.23	0.40	0.33	0.24
10 x 15	2.50	1.65	1.44	0.45	0.40	0.27
11 x 15	2.60	1.70	1.49	0.50	0.40	0.30
12 x 16	3.00	2.20	1.75	0.60	0.45	0.34
14 x 16	3.15	2.40	2.00	0.70	0.50	0.38

A large saving in cost was made by tapping the holes which had to be threaded in the cylinders by machinery at the same time that the holes in the cylinders were being drilled; for instance, in a 10 by 12 cylinder there are sixteen holes which average ¾ of an inch and sixteen small holes for attaching the sections of the jacket to the cylinder. The price for drilling all of these holes was 32 cents, or a cent per hole; nineteen of these holes could be tapped on the machine at a cost of 19 cents, or 1 cent per hole, which is very much cheaper than they could be tapped by hand afterwards:

TIMES OF OPERATIONS ON SHAFTS OF VARIOUS SIZES.

Diameter of Shaft, Inches.	Number of Hours for Turning and Key-Seating Shaft 1 foot long.	Diameter of Shaft, Inches.	Number of Hours for Turning and Key-Seating Shaft 1 foot long.	Diameter of Shaft, Inches.	Rough Weight of Engine Shaft per Foot, in pounds.	Diameter of Shaft, Inches.	Rough Weight of Engine Shaft per Foot, in pounds.
2⅜	1.23	6½	2.98	2⅜	18.17	6	107.21
2⅝	1.33	7	3.22	2⅝	21.80	6½	124.71
2⅞	1.42	7½	3.42	2⅞	25.73	7	143.50
3⅛	1.62	8	3.51	3	27.87	7½	163.63
3½	1.66	8½	3.84	3⅛	34.67	8	185.05
3⅝	1.71	9	4.03	3½	37.10	8½	207.76
3⅞	1.80	9½	4.22	3⅝	39.61	9	231.89
4	1.85	10	4.41	3¾	42.19	9½	257.29
4¼	2.02	10½	4.59	3⅞	47.60	10	283.92
4⅜	2.07	11	4.78	4	50.40	10½	311.92
4½	2.12	12	5.16	4¼	56.44	11	341.43
4⅝	2.17	13	5.54	4⅜	59.53	12	404.04
4¾	2.23	14	5.90	4½	62.69	13	472.08
4⅞	2.29	15	6.29	4⅝	65.94	14	545.16
5⅛	2.37	16	6.67	4¾	69.28	15	631.68
5⅜	2.49	17	7.04	4⅞	72.68	16	715.68
5½	2.54	18	7.42	5⅛	79.80	17	806.40
6	2.80			5⅜	87.08	18	900.48
				5½	91.05		

It may seem strange to make piece work prices on general laboring, but unloading foundry sand was done for 10 cents per ton, whereas 12 cents per ton was paid for unloading coal, because it was dirty, and 13 cents per ton was paid for unloading pig iron because of the wear and tear on the leather mittens or "hand holds" which the men were obliged to wear in doing the latter work.

Too much cannot be said regarding the economies secured by providing proper facilities for doing work. At one plant where I took hold of this subject, they had always been behind in the matter of common grate bars as furnished for horizontal tubular boilers. In fact, the plant was usually three weeks to three months behind in shipping these grates, so that it got to be a scandal for a consumer to receive a car load of boilers and accessories, to have time enough to unload the boiler, set it up, get it bricked up and all piping connections made, and then have to wait three or four weeks before getting the grate bars.

Upon investigating the conditions it was found that the grate-bar patterns, which were of wood, were old, twisted, and did not draw properly. The flasks used for moulding these grates were in similar condition. Of the grates moulded during any given date fully 35 per cent were lost in casting, and it was almost impossible to get a moulder to undertake the "job" of moulding grates, so that each person was given some grates to mould in order to distribute the curse. I went to work and had an entirely new set of grate-bar patterns made of iron, finished all over, rusted and waxed, with two sets of holes tapped for rapping and draw irons. I then had a set of hinged cast-iron flasks made, just taking three pieces of double-bar grate. We gave all these grates to one moulder, paying him 4½ cents for a 36-inch grate. In a very short time he was making from $3.50 to $4.50 per day, and the loss of grates in casting did not amount to 5 per cent. It did not pay to have moulders doing laboring work, so that we evolved the scheme of having a laboring gang come in about 9 o'clock in the evening, shake out all the flasks, and take the red-hot castings out of the foundry proper; another laboring gang came in at about 4 o'clock in the morning, and cleaned up each moulder's floor, brought in from the sand sheds fresh sand, which had been properly tempered the day before by machinery, and made up the moulder's floor with a row of properly tempered old and new sand. This same gang brought in the patterns to be used on each particular floor and all the flasks and moulding boards for each particular pattern, all of which were piled symmetrically so that when the moulder

COSTS OF VARIOUS MACHINE OPERATIONS ON STEAM ENGINES.

BEDS.

Size of Engine.	Drilling Pillow Blocks.	Drilling Other Holes.	Planing.	Babbetting and Putting in Studs.
8 x 12	$0.12	$0.27	$0.50	$0.90
9 x 12	0.12	0.29	0.50	0.90
10 x 12	0.14	0.29	0.60	1.05
10 x 15	0.16	0.35	0.70	1.15
11 x 15	0.18	0.40	0.80	1.25
12 x 16	0.20	0.45	0.90	1.60

CYLINDERS.

Size of Engine.	Boring 1 Mch.	Boring 2 Mch.	Planing.	Vise Work.	Turning Heads.	Drilling
8 x 12	$0.76	$0.60	$0.50	$1.15	$0.22	$0.25
9 x 12	0.80	0.64	0.65	1.20	0.25	0.29
10 x 12	0.88	0.70	0.70	1.20	0.30	0.32
10 x 15	0.96	0.77	0.85	1.30	0.30	0.34
11 x 15	1.02	0.82	0.85	1.60	0.35	0.37
12 x 16	1.12	0.90	0.95	1.60	0.10	0.40
14 x 16	1.44	1.15	1.20	2.25	0.60	0.45

PISTONS.

Size of Engine.	Turning.	Drilling.	Bolt Cutter on Rods.	Rings, Turning.
8 x 12	$0.80	$0.12	$0.12	$0.13
9 x 12	0.88	0.15	0.15	0.14
10 x 12	1.00	0.20	0.20	0.15
10 x 15	1.00	0.20	0.20	0.15
11 x 15	1.20	0.20	0.20	0.16
12 x 16	1.25	0.25	0.25	0.17
14 x 16	1.50	0.30	0.30	0.19

SLIDES.

Size.	Planing Top.	Drilling.
8 x 12	$0.00	$0.07
9 x 12	0.40	0.07
10 x 12	0.40	0.07
10 x 15	0.45	0.07
11 x 15	0.55	0.07
12 x 16	0.70	0.08
14 x 16	1.00	0.10

STEAM CHEST COVERS.

Size.	Planing.	Milling.
8 x 12	$0.27	$0.15
9 x 12	0.30	0.17
10 x 12	0.30	0.20
10 x 15	0.32	0.22
11 x 15	0.35	0.25
12 x 16	0.40	0.25
14 x 16	0.50	0.30

It may seem a difficult thing to make piece work prices on painting, including the striping, of such things as engines, but for

Engines 18 x 12 to 10 x 12 the price was $0.80,
10 x 15 to 12 x 16 " " " 0.90,
13 x 16 to 14 x 18 " " " 1.00, including varnishing.

These prices included varnishing also.

arrived he found the pattern he was to work on, the quantity which he was to make chalked on it, the sand and flasks to work with; and as soon as he was through moulding in the afternoon he returned his pattern to the foundry pattern room, re-marked to suit the number of moulds he had made. This was again checked by the foreman of the laboring gang with the number of good castings removed to the cleaning room, a record being kept of the difference between pieces moulded and good pieces secured; this increased the efficiency of that particular foundry fully 33 per cent.

TIME REQUIRED TO TURN, KEY-SEAT, AND BALANCE, PULLEYS, PER INCH WIDTH OF FACE.

Allowance is made for Pulleys in rough, hours and decimal parts of an hour.

Diameter of Pulley Inches.	Hours Required to Turn Balance and Key-Seat Pulley 1 in. Wide.	Diameter of Pulley Inches.	Hours Required to Turn Balance and Key-Seat Pulley 1 in. Wide.	Diameter of Pulley Inches.	Hours Required to Turn Balance and Key-Seat Pulley 1 in. Wide.
6	.283	54	1.789	100	3.23
8	.346	56	1.852	102	3.29
10	.408	58	1.915	104	3.35
12	.471	60	1.977	106	3.41
14	.534	62	2.040	108	3.47
16	.585	64	2.100	110	3.54
18	.648	66	2.160	112	3.60
20	.711	69	2.220	114	3.66
22	.774	70	2.280	116	3.72
24	.836	72	2.350	118	3.80
26	.899	74	2.41	120	3.84
28	.962	76	2.47	122	3.90
30	1.026	78	2.54	124	4.96
32	1.083	80	2.60	126	4.00
34	1.151	82	2.68	128	4.06
36	1.213	84	2.72	130	4.12
38	1.276	86	2.79	132	4.18
40	1.339	88	2.85	134	4.25
42	1.402	90	2.91	136	4.31
44	1.465	92	2.98	138	4.37
46	1.528	94	3.00	140	4.43
48	1.590	96	3.00	142	4.49
50	1.663	98	3.16	144	4.54

As another instance of economies secured by provision of facilities for doing work, I have quite often had a workman come to me and voluntarily offer to take a certain line of work at a cut in the then prevailing price list, if I would give him certain facilities. In one case such a proposition was made on the condition that I should give the man all of a certain class of work. In this case the workman was

planing cylinders, but his planer was not large enough to permit him to plane the largest two sizes handled in that shop. He offered to take all the cylinders at a 10 per cent reduction if I would give him a new planer large enough to take all of the cylinders, and then give him all of the cylinders to do, and this in spite of the fact that the planer which he was then working on was a relatively new modern planer.

COSTS OF VARIOUS OPERATIONS ON STANDARD BOILERS; HAND WORK.

Setting Flues.		Punching and Reaming
1½-inch and 2-inch flues,	5 cents	Flue Holes,
3-inch flues,	6 cents	30 cents
3½-inch and 4-inch flues,	8 cents	per Hundred
6-inch flues,	12 cents	

Chipping Edges of Sheets of Boilers, 4½ cents per lineal foot.
Caulking, 2 cents per lineal foot.
Punching Rivet Holes, 15 cents per hundred.
Riveting Boilers with either steam or hydraulic rivets, 40 cents per hundred rivets, an average day's work being about one thousand ¾-inch rivets.
Stay Bolts, 3¾ cents each for tapping, putting in, and driving.

Premium Work.

I have often found it of material advantage to pay an extra price on an extra production, although it made the average cost of the total output of such a piece more than the average piece-work price. Ordinarily this would not seem to be profitable, but it often happens that the production of two more pieces of a particular part increases the whole capacity of the plant just so much, say 10 per cent, or even 5 per cent, without any increase in the cost of the other parts, with, of course, collateral saving in general expense. It also has a further effect of prodding along other workmen or departments, as among good honest workmen there is an inherent dislike to feel that they are holding back the work or that the output is waiting for them.

A further exemplification of this spirit is shown by the advantages gained in putting up on a large blackboard, so that all of the workmen in the shop can easily see it, the date at which a set of machines was put into the shop, and the date at which they are expected to be completed, and stating the total number of hours in which a previous similar lot was completed. The men invariably want to beat their own record.

EDITORIAL COMMENT

Accident and Conquest.

ANOTHER Zeppelin dirigible has gone the way of its several predecessors (fortunately without loss of life to passengers or crew) and the first commercial aerial transportation enterprise ends almost before it had begun. Those enthusiasts, however, who see the "conquest of the air" in every flight that ends without actual disaster, will be only briefly if at all cast down. They forget that conquest consists not in ability to raid the enemy's country hither and yon, occasionally or even frequently, when his forces are absent, but in ability to occupy that country permanently and securely against any violence the enemy can offer. It is on this point that accidents of the class of the repeated destructions of Zeppelin's ships teach a lesson wholly different from that conveyed by the deplorable, but probably wholly accidental, destruction of the Erbsloeh.

As we have said before in these pages, there is no fundamental reason why the best present aviation records, in any direction, should not be enormously and even indefinitely excelled—under special conditions. There is no fundamental reason why a dirigible airship should not cross the Atlantic—under special conditions. Yet the air would be as far from conquest as ever, because the conditions making up the largest factor in the favorable result are special—accidental or occasional, wholly meteorological—now, and in our opinion always, wholly beyond the control of the aviator or aeronaut.

In our belief, there are several fundamental facts or factors that remove the solution of the problem of "conquest of the air" to an inaccessible distance. These are: First, that all air craft are of necessity extremely frail in comparison with any other form of vehicle used for traffic or transportation; second, that these relatively frail craft must always be subject to an extreme violence of the medium navigated—a violence relatively far greater than that of any other medium practically navigated by man; third, that any serious accident resulting from either the frailty of the craft or the violence of the medium almost necessarily involved wholly fatal results.

These obstacles are of a different order from those that opposed the practical success of the railway or the steamship; and there is not now, as a treasury to draw from, such an enormous unrealized margin of mechanical knowledge as lay ahead of the inventor of the steam engine. Like many other developments heralded as revolutionary, but probably in more limited degree, aerial navigation will serve some few purposes, old or new, better than other agencies. It does not seem likely that any of these purposes will be of much economic importance. It does not seem likely that aerial vehicles can ever be depended upon to perform even these services infallibly. It seems highly improbable that the navigation of the air has any serious meaning for the serious transportation and traffic problems of the world.

The Bureau of Mines.

OUR editorial last month on the Bureau of Mines called forth very interesting comments from some of the leading mining engineers of the United States; but the appointment of Mr. George Otis Smith as acting director of the new Bureau, and the transfer of the entire technologic branch of the United States Geological Survey with its personnel, property, and equipment to the

Bureau of Mines, forestalls further discussion of the subject. In substance, the same work will be carried on by the same men. It is to be assumed, therefore, that the methods, the efficiency, and the scientific standing of the investigations will be unchanged; and there remains only the question whether the change of spirit or purpose, imposed or implied by the act of Congress creating the Bureau, will induce a sympathetic change on the part of mine owners and managers that will in a more or less tangible way influence the results.

It is interesting to note that out of a little more than $500,000 appropriated in total for the Bureau, including salaries, rent and expenses of removal, $310,000 is devoted to the investigation of mine accidents, and under the plans approved by the Secretary of the Interior about two-thirds of this sum will be spent on the maintenance and extension of rescue stations; $40,000 is allotted to the investigation of explosives, $14,000 to the use of electricity in mining, $8,000 to appliances for the prevention of mine accidents, and $5,000 to the examination and codification of mining laws. The other large field of activity laid out for the Bureau is the analysis and testing of coals, lignites, ores, and mineral fuel substances, for which $100,000 is appropriated. One-quarter of this sum will be devoted to inspection of government fuel purchases, and the remainder to chemical, physical, and efficiency investigations of fuels, including the study of lignites and peats and of briquetting.

If money and activity are to be expended in mining investigations under Government direction, the apportionment of most of it to matters connected with coal mining certainly seems expedient; for there undoubtedly the largest remaining opportunity for investigation and improvement is to be found. It is difficult to see how the Bureau could greatly instruct or assist the metal miner or metallurgist. Indeed, in no part of the field is there any close analogy to agriculture, which is carried on by small individual enterprise incapable of making far-reaching investigations. Mining is generally in the hands of large corporations, already energetic in research and in improvement of methods. It is to be inferred that in some other way the Bureau of Mining will contribute to economic advantage and the general good.

THE adjustment of the threatened labor troubles on the Pennsylvania Lines is a happy exhibition of the good wrought by patient conference, and of the power of the Fair Deal to prevail, steadily though quietly, against even the threatened sway of the Big Stick. It is an eminently common-sense adjustment of questions that at one time seemed likely to lead to a great and much-to-be deplored strike. Without abandonment of ideals, without abatement of discipline, the danger has yielded to common-sense and the fair deal. And Ideals, Common-Sense, the Fair Deal, and Discipline, are four of Harrington Emerson's twelve principles of efficiency. The first of these is brilliantly set forth in this issue. The second, Common-Sense, will form the subject of Mr. Emerson's September article.

AN unavoidable interruption, due to the illness of the author, occurs this month in the publication of Mr. Claydon's series on foundry management and foundry costs. It was the author's purpose in this installment to bring together the plans and methods suggested in preceding articles, and show how they operate jointly in a simple and logical system for the prevention of waste and the reduction of expense. The postponement of this concluding article will be for a month only, and it will appear in our September issue.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

POWER PLANT ECONOMIZERS.

CHARTS AND DATA FOR DETERMINING THE EFFICIENCY AND ECONOMY OF ECONOMIZER INSTALLATIONS.

Frank Kingsley—Engineering Record.

THE charge often made against economizers, that they do not "economize," is refuted by Frank Kingsley in an extremely practical article contributed to *The Engineering Record* for June 4. Mr. Kingsley does not argue that an economizer is always an economical addition to a power plant, but he believes that when properly installed to meet certain conditions it proves to be an exceedingly profitable investment. Notwithstanding the number of factors which enter into the solution of economizer problems, Mr. Kingsley finds the economizer as susceptible of as nearly exact analysis as any other item of power-plant equipment. In a series of charts, which are reproduced on the pages following, he indicates clearly the conditions governing efficient and economical operation of economizer installations.

Since the economizer is simply a means for transferring heat from gas to water within a very limited range of temperature, the rate at which the transfer takes place is equal to the square of the mean temperature difference between the gas and the water, divided by a coefficient of resistance to the passage of heat. This relation may be expressed by the formula $Q=x^2/a$, in which Q is the number of B. th. u. transferred per hour per square foot of surface in the economizer, and x is the mean difference in temperature between the gas and the water. On account of the limited range of temperature through which the economizer operates, the arithmetical mean value of x may be used for the sake of simplicity without danger of serious error. The value of the coefficient a is close to 150 for all well designed, modern economizers, variations from this value being usually less than 10 per cent., although in old, carelessly set economizers it may rise as high as 200.

"The test of an economizer is, manifestly, the determination of the coefficient of resistance. It fixes the relative economy, and the actual ability to absorb heat, under all reasonable variations of gas and water temperature. In order to obtain it, the entering and leaving temperatures of gas and water must be averaged for a considerable period of steady load. The area of the economizer and the weight of water passing through it per hour must also be determined." From these data the coefficient of resistance may be determined from the formula

$$a=\frac{A}{4}\,\frac{[(T_1+T_2)-(t_1+t_2)]^2}{N(t_2-t_1)}$$

where T_1 and T_2 are the entering and leaving temperatures of gas, t_1 and t_2 the entering and leaving temperatures of water, N the pounds of water fed to the boilers per hour, and A the area of the economizer in square feet. This formula, of course, cannot be used to de-

termine what a proposed economizer will do in operation. The number of variables affecting economizer operation is so great as to preclude the use of anything but graphical expression of the data on which such a determination can be based.

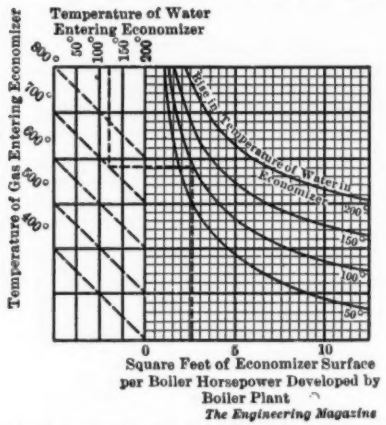


FIG. 1. AREAS OF ECONOMIZERS REQUIRED UNDER VARIOUS CONDITIONS.

The most frequent economizer problem is the determination of the area required to produce a given increase in feed-water temperature, the temperatures of gas and water entering the economizer being known; in certain cases the area may be specified and the rise in feed-water temperature is to be determined. The areas of economizers are usually expressed in square feet per horse power developed by the boilers. Since variations in feed temperature and steam pressure cause little difference in the weight of water required per boiler horse power, the boiler horse power serves also as a measure of the weight of water passing through the economizer; by assuming a steam pressure of 160 pounds and a temperature of water entering the economizer of 100 degrees, the chance of serious error becomes negligible. The remaining factor required to determine the rate of heat absorption and the necessary area for any entering gas temperature and rise in water temperature, namely, the final temperature of the gas as it leaves the economizer, is determined by the fact that, in practice, the drop in temperature of gas passing through the economizer is invariably close to twice the rise in temperature of the water.

The curves in Figure 1 are based on these considerations. The lines at the left of the diagram are merely a graphical device for subtracting the temperature of the entering water from that of the entering gas. From this initial difference, the mean difference and also the heat units absorbed follow for any particular rise of feed temperature; the rate of heat absorption per horse power and the temperature rise determine the necessary area per horse power. The method of using the diagram is shown in the dotted line: a line is projected downward from the point of entering water temperature to intersect the line of entering gas temperature, and from the point of intersection a horizontal line is drawn to the curve of feed temperature rise. The necessary area of economizer per horse power is shown immediately below the latter point of intersection.

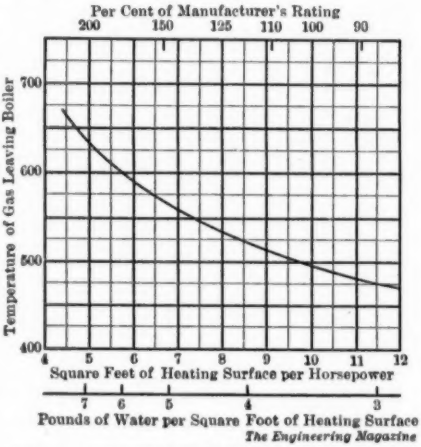


FIG. 2. APPROXIMATE FLUE TEMPERATURES OF STEAM BOILERS.

The temperature of gas entering the economizer is a factor which cannot be determined positively for a proposed plant. It is largely a matter of extent of heating surface under good operating conditions and fair fuels, and its estimation must be based largely on experience. The curve in Figure 2 showing ap-

proximate flue temperatures is drawn through a large number of plotted results of actual boiler tests. With exceptionally good fuels the temperatures may be as much as 50 degrees lower than those shown; with extremely low-grade fuels or careless firing they may be as much as 75 degrees higher.

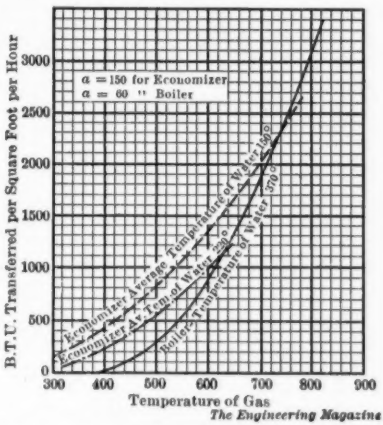


FIG. 3. RELATIVE EFFICIENCY OF BOILERS AND ECONOMIZERS.

Manifestly it is desirable to instal economizers only where they can absorb more heat than the same amount of boiler heating surface. Absorption of heat is more efficient in the economizer than in the boiler only under certain conditions. Boiler heating surface can have a coefficient of resistance as low as 60, less than half that of the economizer. The thick, soot-covered, cast-iron tubes of the economizer are able to compete with the thin sheets of boiler heating surface only because of the low temperature of the water they contain. However, with an average water temperature of say 370 degrees, due to a steam pressure of 160 pounds, the boiler is less efficient at low gas temperatures because the "temperature head" between gas and water is much less than for the economizer, where the mean water temperature may be 150 degrees, or even less.

This is shown in Figure 3, where the heat units absorbed by 1 square foot of boiler surface with a water temperature of 370 degrees and a coefficient of resistance of 60 are shown for various gas temperatures. The two dotted curves show the heat units absorbed per square foot of heating surface by economizers with coefficients of resistance of 150, containing water at average temperatures of, respectively, 150 and 220 degrees. At all gas temperatures below 740 degrees, the economizer of low water temperature absorbs more heat units than the boiler. With gas temperatures between 400 and 500 degrees the economizer absorbs from three to ten times as much heat as the boiler, and since flue temperatures below 500 degrees are common, the conclusion is inevitable that many power plants now in existence would have been better off had they dispensed with some of their boilers and installed economizers in their place.

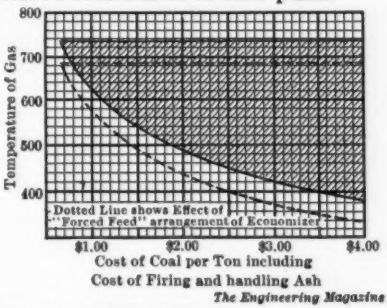


FIG. 4. SHADED AREA GIVES LIMITS OF GAS TEMPERATURE FOR PROFITABLE ECONOMIZER OPERATION WITH WATER AVERAGING 150 DEGREES.

The installation of an economizer is not always a profitable investment, however. The economizer may be vastly more efficient, relatively, than the boiler, and yet not absorb enough heat to warrant the first cost of its installation. "An economizer of ordinary type is worth in place about $1.15 per square foot of heating surface. The building space it occupies is worth about 10 cents more. The interest and depreciation may be taken at 12 per cent., or, say, 15 cents per year. Repairs amount to 3 cents and power to drive scrapers 2 cents. The fixed charges are, therefore, 20 cents per year; and if profit be taken at 4 per cent., or 5 cents more, it may be generally assumed that an economizer which does not earn about 25 cents per square foot per year is not a profitable investment."

In Figures 4 and 5 are shown the limits of gas temperature within which economizers carrying water at, respectively, 150 and 220 degrees, at various prices of

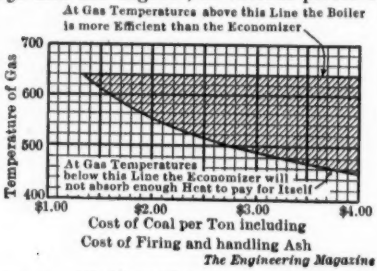

At Gas Temperatures above this Line the Boiler is more Efficient than the Economizer
Temperature of Gas
700
600
500
400
At Gas Temperatures below this Line the Economizer will not absorb enough Heat to pay for Itself
$1.00
$2.00
$3.00
$4.00
Cost of Coal per Ton including Cost of Firing and handling Ash
The Engineering Magazine

FIG. 5. SHADED AREA GIVES LIMITS OF GAS TEMPERATURE FOR PROFITABLE ECONOMIZER OPERATION WITH WATER AVERAGING 220 DEGREES.

coal per ton will absorb enough heat units to make their installation profitable. The curves are based on a 10-hour working day and a nearly constant normal load, but they would also apply roughly to power plants with variable loads at 30 per cent. power factor. The dotted line in Figure 4 shows the effect of the forced-feed arrangement, in which the water and gas move in opposite directions and the hottest water leaves the economizer at the end at which the hottest gas enters This method of operation obviously prevents the consideration of temperature differences

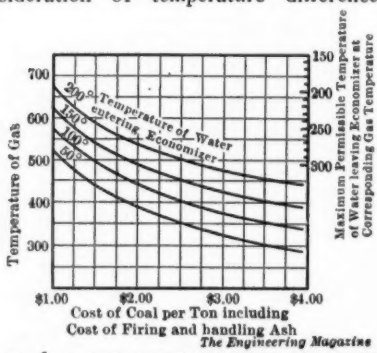


FIG. 6. LIMITS OF TEMPERATURE FOR PROFITABLE ECONOMIZER INSTALLATION.

based on a mean water temperature, and a separate set of curves for forced-feed economizers is given in Figure 6, showing the minimum profitable temperatures of gas leaving the economizer, with various temperatures of entering water, and also the temperatures of water leaving the economizer, corresponding to the various gas temperatures above which the economizer is less efficient than the boiler.

"Since the drop in temperature of gas is always equal to about twice the rise in temperature of feed, it follows that, for any combination of temperatures of entering water and gas, with coal at a certain price, there is a maximum permissible rise in feed water. Any attempt to go beyond the maximum will result in either having the final gas temperature so low that part of the economizer is a bad investment or else having the final water temperature so high that a boiler

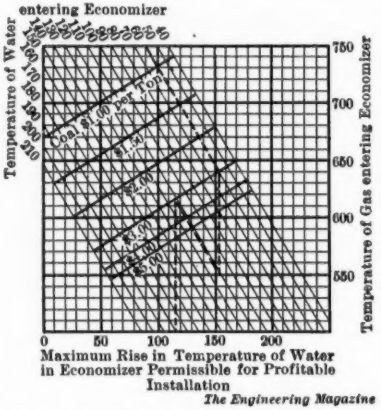


FIG. 7. TEMPERATURE RISES IN ECONOMIZERS.

would absorb more heat than the economizer. These maximum permissible rises in feed temperature are shown in Figure 7." The maximum permissible rise is found from the diagram by projecting a line downward from the point of intersection of the lines representing coal cost and temperature of entering water, and the entering gas temperature to give this rise by horizontal projection from the same point. The dotted line shows, for instance, that for coal at $3 per ton and water entering the economizer at 60 degrees, the maximum permissible rise is 153 degrees, and that in order to make the economizer most effective the boilers should be designed to give a flue temperature of 640 degrees.

It shows also how the chart may be used to indicate the maximum permissible rise when the gas temperature is not that theoretical most desirable. In the diagram the gas temperature is taken at 550 degrees. A line is projected downward from the intersection of the coal cost and water temperature lines to intersect the 550-degree horizontal line, and from the point of intersection a line is drawn parallel to the water temperature lines to reach the $3 coal line. Immediately below the point so established is read 115 degrees, the approximate maximum permissible rise in water temperature under the conditions.

THE ELECTRIC FURNACE FOR STEEL CASTINGS.

A CONSIDERATION OF THE TYPES OF ELECTRIC FURNACES SUITED TO THE PRODUCTION OF STEEL CASTINGS AND OF THE COST OF THE PROCESS.

G. Hooghwinkel—Sheffield Society of Engineers and Metallurgists.

LAST August we printed in these columns a comprehensive table showing the comparative costs of producing steel in foundries by the open-hearth, Bessemer, crucible and electrical processes. The purpose of the compiler of the data, Dr. Bradley Stoughton, was to indicate the future relation of electric steel-making processes to present methods of foundry work. His estimate of the possibilities of the electrical process Dr. Stoughton expressed as follows: "It is evident that the electric process can hardly hope to compete with any of the prevailing processes except the crucible process, and then usually only when electric power is available at 3 cents per kilowatt hour or less. It may well be, however, that recent developments in the electric process will bring its cost down to the point where the converter process will be superseded to some extent, especially in view of the very high quality of electric steel."

A more optimistic prediction of the future of the electric furnace in the production of steel castings is made by G. Hooghwinkel in a recent paper before the Sheffield Society of Engineers and Metallurgists, abstracted in *The Electrician* for June 3. "The electric furnace," he says, "will be found a necessity in all large steel works for the production of high-class uniform steel for different purposes in large quantities and to various specifications at reasonable prices. The chemical, physical and machining qualities of steel castings produced electrically are far superior to those produced in crucibles on account of the facility and safety with which any specified quality can be produced."

Mr. Hooghwinkel assails the belief of many manufacturers that the electric furnace is destined to be used only where very cheap electric power is available. The cost of power is only a small fraction of the total cost of the electrical process, about 3 per cent. for hot charges and about 8 per cent. for cold. Even with a town supply at a price between ½d. and 1d. per unit, the production of electric steel is a commercial proposition of no uncertain merit. Where a cheap supply of electric power is available from the utilization of waste furnace gases, the power can be used more economically and profitably in large-scale electric-furnace operation than in supplying the other demands of the steel works. Electric furnaces supply an excellent central-station load on account of their high power factor (50 per cent. for hot charges and 75 per cent. for cold), and where furnace operations can be arranged so as not to coincide with peak loads, as is done at Niagara Falls and other places in the United States, supply companies find it advantageous to supply current at very low rates.

The superiority of the electrical over the crucible process lies in the disuse of the expensive and short-lived crucible, which has the inherent disadvantage of introducing impurities into the steel. In addition, the high temperature of the cast is of advantage in manufacturing complicated parts. Castings such as have been made for a considerable time in Girod, Stassano, Héroult, Kjellin and

other furnaces are distinguished by a very high elongation value (25 per cent. with a breaking strength of 60,000 pounds per square inch) and low percentages of sulphur (0.03 per cent.) and of phosphorus (0.06 per cent.), properties particularly valuable in railway and motor car materials, etc. The pure Swedish iron formerly used in the crucible furnace for this class of work cost £10 per ton, and the casting about £15 to £20 per ton. As shown in the accompanying cost data, the cheaper materials used and the lower cost of operation of the electric furnace have reduced the cost of production of steel castings in a 1-ton Stassano furnace to £9 per ton. The cost of labor is materially affected by the simplicity of handling of the simple pouring furnace, which entails much less attendance than the heavy and cumbersome crucibles. Furnaces for this class of work should be of from one to three tons capacity. The cost of such a furnace complete varies from £750 to £1,500, according to the type chosen. A 1-ton Stassano furnace will require an average of 200 kilowatts during the four hours the power is required, using about 800 units per ton of steel produced. The lists of installations published in these columns in our January, 1909, and May, 1910, numbers show that at least 60 electric furnaces are now engaged in the production of steel castings. "One or more electric furnaces," says Mr. Hooghwinkel, "should be installed in every iron and steel works with a pretence of up-to-dateness, and not only this, but in such works as naval and shipyards, locomotive and carriage works, bridge-building works, machine shops, electrical works, etc., small electric furnaces producing steel for castings should be indispensable. The very materials used, scrap, trimmings, stampings, punchings, steel and iron borings, etc., which are always used at such works, point to the utility of such furnaces not only as refuse destructors, but as the means of producing their own castings at a very low price, thereby making them independent of the foundries, and giving them facilities for regulating deliveries to meet with modern demands for promptness.

"The electric furnace will also replace the small converter which is now often used with or instead of the open-hearth, in shipyards, for example. Such a converter as a rule produces a quantity in excess of the requirements, so as to prevent the converter from cooling off. The electric furnace is a combination of the cupola furnace and the small converter, and produces a superior material (less sulphur and phosphorus) from an inferior charge (60s. instead of 90s. for special pig) in smaller quantities, at a lower cost. A further product to be made in the small electric furnace is malleable cast iron, which is now made in the cupola furnace, the crucible, the small converter and the reverberatory furnaces at higher cost, at least for small quantities, on account of the high fuel charges and expensive special pig iron used."

In choosing a furnace it must be remembered that the initial charge to be used will be cold. A resistance furnace, or, better still, a combination furnace, will fulfil the requirements; the Héroult, Stassano, Girod and Rodenhauser furnaces have given excellent results in the production of steel castings. When fairly pure materials are used and no refining but smelting and "killing" is required, a plain induction furnace such as the Kjellin will give an ideal crucible steel; furnaces of this type rarely exceed a capacity of two tons. Inherent electrical disadvantages and the difficulty of obtaining a hot and fairly liquid slag prohibit the use of induction furnaces when the materials are so impure that refining is required. A type of furnace which combines the advantages of the pure resistance furnace (ease of handling and regulation) with those of the arc furnace (adaptability to current supply and charge materials) is the Grönwall furnace, which uses two-phase current in two vertical electrodes, the common return being through the bottom lining. The furnace is simple in construction and requires no rotary movement on account of the vertical and horizontal effect of the two phases. Maintenance charges for lining, a rammed mixture of dolomite or magnesite and tar, are small.

Cost of Steel Production and Furnace Repairs in Actual Practice.

Girod Furnace at Ugine, 2 Tons.

Charge: Cold scrap, turnings and some cast iron and iron ore. Total time required: Rated at 275 kilowatts, 5 hours per ton of steel.

	Per Ton.		
Lining repairs: (dolomite or magnesite paste)	£0	6	0
Electrodes consumption: (40 pounds, ordinary retort carbon)	0	4	0
Energy consumption: (850 kilowatt-hours plus 10 per cent. loss, say 900 units at ½d. per unit)	2	0	0
Wages (2 men)	0	4	9
Materials charged, say, 1 ton scrap	3	0	0
224 pounds lime, 224 pounds iron ore, ferro alloys, hammer scale	0	3	6
Upkeep of furnace, wear and tear of plant, ladles, etc.	0	12	0
Depreciation	0	1	6
	£6	11	9

Cost of furnace plant complete without power plant, £1,000. In case molten steel from a Bessemer converter, Martin or open hearth furnace is charged into the furnaces, the energy consumption and cost is reduced to one-third of the values given.

Stassano Furnace at the Bonn File Works.

Replacing 32 crucible furnaces of 6 crucibles, each of 75 pounds capacity. Rating: 185 kilowatts. Charge: cold. Soft scrap, etc. Smelting period: 3½ hours. Refining period: 1 hour. Total time: 4½ hours. Daily production of cast steel, 8 tons.

Energy consumption per ton of steel, 909 units at ½d.	1	18	0
Electrodes consumption	0	2	6
Repairs to lining (£20 per lining, 33 charges)	0	11	0
Wages (3 men)	0	8	8
Cooling water (440 gallons per ton)	0	0	5
Upkeep of furnace, wear and tear of plant	0	10	0
Materials: 1 ton scrap	3	7	0
44 pounds hammer scale, at 17s. per ton	0	0	4
44 pounds lime, at 12s. per ton	0	0	3
17½ pounds ferro-silicon (12 per cent.), at 150s.	0	1	2
9 pounds ferro-manganese (80 per cent.), at 220s.	0	0	11
1½ pounds aluminium	0	1	2
Depreciation, 10 per cent.	0	4	2
Duration, 5 hours. Total	£7	5	7

This means per ton of finished castings 1.5 tons of molten steel, less 0.5 ton of scrap, say, 180s., £9. Cost of furnace complete, £1,500. The lining lasted an average of 70 charges.

Kjellin Furnace at Gysinge.

1½ tons charge of cold pig iron, very pure iron ore, briquetted. Rating, 175 kilowatts. Single-phase, 15 periods, 500 volts, power factor, 0.7. Produced crucible quality steel.

Cost per ton of steel (melting only):—			
Energy consumption, 800 units, at ⅛d. (water power)	£0	7	10
Repairs to lining	0	3	5
General expenses	0	5	7
Wages	0	7	3
Cost of casting	0	4	6
Materials: 1 ton of scrap at 80s.	*4	0	0
Flux	0	2	1
	£5	10	8

The low figure is, of course, due to the low charges for power. Interest and depreciation are also not included.

Rodenhauser Furnace at Volklingen, 2 Tons Capacity.

Rating: three phase, 350 kilowatts, 500 volts, 50 periods, 0.8 power factor. Refining only: Charge, hot from basic Bessemer converters containing 0.08 per cent. phosphorus and 0.1 per cent. sulphur. Product: Crucible steel for castings.

Energy consumption, 300 units at 1.09d.	£1	7	0
Heating up	0	1	2
Repairs to lining (10 days, or 160 tons per lining)	0	1	6
Other repairs	0	0	10
Wages	0	2	0
Materials: 1 ton liquid steel	3	9	0
Mill scale, lime, ferro-silicon	0	4	5
Interest and depreciation (15 per cent.)	0	1	5
	£5	7	4

Cost of complete furnace, £2,700. The cost of power per unit in this case was, of course, very high.

The hottest part of the charge is the slag, so that refining can be carried on until the desired result is obtained.

No type of furnace unites all the conditions which must be satisfied by a furnace for the production of steel castings in the same degree. Local conditions and requirements must govern the choice. It is possible, however, to indicate the requirements of a satisfactory furnace and the furnaces which are particularly adapted to fill them. These are:

(a) Good thermal efficiency and high power factor combined with medium out-

put (Héroult, Girod, Grönwall and Rodenhauser);

(b) Easy and simple handling, regulation and repairs (Grönwall, Kjellin and Rodenhauser).

(c) Adaptability to all kinds of initial materials, charged either hot or cold (Héroult, Girod, Stassano, Grönwall and Rodenhauser);

(d) Ability to work with an ordinary three-phase supply, and a fairly constant energy consumption (Stassano, Grönwall and Röchling-Rodenhauser);

(e) Ability to use low voltage at the furnace (Girod, Stassano, Grönwall and Héroult);

(f) Ease of refining with a basic slag, even with impure materials high in sulphur and phosphorus (Girod, Röchling-Rodenhauser and Héroult);

(g) Production of a homogeneous bath of molten metal, even after the refining process has been completed (Rodenhauser, Kjellin, Frick and Grönwall).

"It may be stated generally that all the furnaces being vertical electrodes through the roof of the furnace offer the disadvantage of heavier repairs to the roof lining, due to the unequal heating, and that all furnaces using electrodes have the disadvantage of heavy energy losses (over 10 per cent.) in the electrodes. One of the future modifications will certainly be in the direction of the use of metallic electrodes inclined at an angle of 45 degrees."

THE DESIGN OF FURNACE ELECTRODES.

SIMPLE RULES FOR PROPORTIONING ELECTRIC-FURNACE ELECTRODES ACCORDING TO HERING'S LAW.

Carl Hering—Electrical World.

ONE of the first results of an investigation of the design of electric-furnace electrodes, begun more than a year ago by Carl Hering, was the demonstration mathematically of the law of energy loss which now bears Mr. Hering's name. Briefly stated, Hering's law is this: that the total waste of energy in the electric furnace is a minimum when the thermal conduction losses, due to the conduction of heat from the furnace through the electrodes, and the joulean losses, due to the expenditure of electrical energy in heating the electrodes by the passage of the working current, are equal and cancel each other. This remarkable conclusion aroused a great deal of criticism, much of it adverse, and certain theoretical objections to the general application of the law have proved to have been well taken. By practical experiment, however, Mr. Hering has demonstrated conclusively that under the conditions of practice the law is sound. He has reduced the design of furnace electrodes to a few very simple rules, which, together with a table of specific physical constants determined by Mr. Hering, are given briefly in the pages following, after an article contributed to *Electrical World* for June 16.

"The complication in the design of an electrode lies in the fact that, being necessarily a good electric conductor, it was naturally also a good or fairly good heat conductor and therefore carried off heat from the furnace, whereby it chilled the furnace products around the hot ends of the electrodes; this not only wasted a lot of heat, but reduced the capacity of the furnace, and in some cases very greatly, by reducing the temperature of those parts located around the electrodes.

"The total loss is made up of two parts: one, that due to the resistance, and the other, that due to this loss of conducted heat, and the question is: what proportions will make this total loss the least? It is evident, without any mathematics, that if the current in a given electrode is increased (or the cross section for a given current diminished) the electrode will become hotter and hotter due to its electrical resistance. By thus increasing the resistance heat, a point will evidently be reached when the hot end will be heated by the current to the same temperature as that of the furnace,

TABLE OF ELECTRODE CONSTANTS.

Temperature Drop. C.	Fahr.	Section *s*. Square Inch.	Square Centimetre.	*e*. Volts.	Current *i*. Inch Units.	Centimetre Units.
Copper						
800	1,472	.000014	.000036	0.18	70,300	27,700
1,000	1,832	.000014	.000035	0.22	71,800	28,300
1,200	2,192	.000014	.000035	0.26	72,800	28,700
1,400	2,552	.000014	.000035	0.30	73,400	28,900
1,600	2,912	.000013	.000034	0.34	73,900	29,100
1,800	3,272	.000013	.000034	0.38	74,300	29,300
2,000	3,632	.000013	.000034	0.42	74,600	29,400
Iron						
800	1,472	.000100	.00026	0.29	10,000	3,900
1,000	1,832	.000100	.00025	0.30	10,000	3,900
1,200	2,192	.000099	.00025	0.43	10,100	4,000
1,400	2,552	.000099	.00025	0.49	10,100	4,000
1,600	2,912	.000098	.00025	0.56	10,200	4,000
1,800	3,272	.000098	.00025	0.63	10,200	4,010
2,000	3,632	.000098	.00025	0.70	10,200	4,010
Graphite						
1,000	1,832	.00025	.00063	1.3	4,100	1,600
1,200	2,192	.00023	.00059	1.4	4,300	1,690
1,400	2,552	.00022	.00057	1.5	4,500	1,760
1,600	2,912	.00022	.00055	1.5	4,600	1,810
1,800	3,272	.00021	.00054	1.5	4,700	1,860
2,000	3,632	.00021	.00053	1.5	4,800	1,890
2,500	4,532	.00020	.00051	1.5	5,000	1,960
3,000	5,432	.00020	.00050	1.5	5,100	2,010
Carbon						
1,000	1,832	.00074	.00187	1.9	1,360	530
1,200	2,192	.00064	.00162	2.1	1,570	620
1,400	2,552	.00057	.00145	2.3	1,750	690
1,600	2,912	.00052	.00133	2.5	1,920	750
1,800	3,272	.00048	.00123	2.7	2,070	810
2,000	3,632	.00045	.00115	2.9	2,200	870
2,500	4,532	.00040	.00102	3.3	2,500	980
3,000	5,432	.00037	.00093	3.7	2,700	1,080

and under those circumstances it follows that no furnace heat will leave through the electrodes, because no heat will flow between two points which have the same temperature. Hence, under those conditions the furnace will have its full capacity because there will be no chilling around the electrodes, and there will be no loss of furnace heat through the electrodes, which then act as a perfect heat insulator. The fundamental principle of furnace design is, therefore, *so to proportion the cross section and length that the current will heat the hot end to the furnace temperature.*" The methods of design described below, and the table of physical constants appended, are based on this principle.

"The rule for determining the best cross-section is as follows: The current and the drop of temperature between the inside of the furnace and the outside ends of the electrodes are supposed to be given by the specifications of the furnace. The length of the electrode can be made anything one chooses, but some definite length must be fixed before the cross-section can be determined, as the cross-section depends on the length.

"For this drop of temperature, find the corresponding value of s in the accompanying table for the material which is to be used. This number is the specific section for that drop of temperature; it is quite analogous to specific resistance, that is, to ohms per cubic inch or per mil-foot, etc., at a high temperature; it represents the section per ampere and per inch (or centimetre) length. Hence, the proper cross-section (in square inches or square centimetres) is equal to this specific section s multiplied by the current in amperes and the length (in inches or centimetres, as the case may be). By repeating this very simple calculation for each of the several materials

and for various lengths, if there should be any choice in them, the results will show what it is best to use and will enable the cost of the electrodes to be readily determined. The size thus obtained is the one which will not chill the furnace product by the abstraction of heat, and which corresponds approximately to the section giving the condition of least total loss of energy in the electrodes.

"It is also often of interest to know what the total loss of energy in the electrode is. This is also an extremely simple calculation when the electrode is proportioned as above described. From the accompanying table find the value of e for the given material and temperature drop, and multiply it by the current; the result is the total loss in watts for one of the electrodes. This value of e is again a specific quantity, being the total loss (in watts) per ampere for each electrode. It applies correctly only to electrodes proportioned as above described.

"Sometimes it is also of interest to find out how much current could be used in an existing furnace with given electrodes, because in any case, no matter how badly the electrodes have been proportioned, it is always possible to so change the current (generally by increasing it) that the existing proportions are correct; and as electrodes proportioned according to the older rules are often far too large, the capacity of such a furnace can, by increasing the current, generally be greatly increased besides diminishing the relative loss. To determine this correct current, find the proper value of i in the accompanying table, multiply it by the existing section in square inches and divide it by the length in inches (or use centimetres and the corresponding value of i); the result is the current in amperes which corresponds to those proportions of the electrodes. This value of i is again a specific quantity, being the proper current per square inch section, for an inch length."

In all these calculations the length is only that part of the electrode embedded in the walls, which is necessary to carry the current from the outside to the inside. The portions which project beyond the walls either inside or outside have entirely different functions and their proportions are based on entirely different considerations. The essential part may, however, without any great error include a portion of that embraced by the water-jacketed terminal and a portion of that which may project into the inside. Any portion of the electrode outside the furnace is, of course, a dead resistance, and the loss in it cannot be utilized to check the outflow of furnace heat, as is the case with the resistance loss of that part embedded in the walls; hence, exterior portions should be made as short as practicable, and wherever possible the terminal should be placed quite close to the furnace wall and the electrode fed through it.

With respect to economy of both materials and power, the materials available for furnace electrodes rank in the following order: copper, iron, graphite and carbon. The smaller and more efficient metal electrodes should be used wherever practicable. "The proper cross sections for all materials and for the same length and current become smaller the higher the temperatures, and as this decrease seems to becomes less and less, it follows that at high temperatures the cross section becomes less and less dependent on the temperatures, which means that for the arc furnaces, in which the temperatures are higher, it is not necessary to know these temperatures accurately in order to calculate the sections, as they will be nearly the same for all the higher temperatures. For iron the section is practically the same for all temperatures. This is not true, however, of the power loss for the same current, as this seems to increase roughly in proportion to the temperatures, although for graphite it seems to approach toward constancy. For the same electrode, however, if the temperature is increased by increasing the current, the total loss is very nearly proportional to the temperature for all materials. Hence, as far as loss in the electrodes is concerned, the temperature of a furnace should not be any higher than what is required for the desired thermal reactions."

MARINE APPLICATIONS OF ELECTRICITY.

A SYMPOSIUM DEALING WITH THE APPLICATIONS OF ELECTRIC POWER IN MARINE WORK.

The Electrician.

A SPECIAL issue of *The Electrician* for June 10 contains a symposium of fifteen papers dealing with various applications of electrical engineering in marine work. It is not our purpose here to give an extended abstract of any of these papers. They all possess an interest and authority which would render a selection difficult. We present below, however, a brief summary indicative of the scope of the discussion, which will incidentally demonstrate the growing importance of electrical engineering as applied to marine work.

An editorial review of the evolution of electrical engineering in the British Navy traces progress in the employment of electrical apparatus on war vessels from the earliest application to the present time. The diverse conditions of ship and shore applications of electricity are emphasized. The general lay-out of the electrical equipment and the way in which it is maintained are then described, and the paper concludes with a consideration of the methods employed in ship lighting and a summary of the directions in which the electric motor is employed on board a modern battleship.

The application of electric motors to marine propulsion, as might be expected, receives a good deal of attention. No fewer than four systems are described. Henry A. Mavor investigates a special case of marine propulsion where the existing method of driving is admittedly efficient and cheap; he shows that while the possibilities of economy are restricted, there is still a strong case for electrical methods. The logs of two voyages are used to illustrate the argument that the "load factor" is likely to be an important element in the consideration of economical working at sea as it is on land. William P. Durtnall presents the claims of his well known "Paragon" system. After a brief reference to the conditions to be observed in marine propulsion, Mr. Durtnall considers in detail the effect of substituting for steam drive the Paragon electric system in two special cases. In the first case, that of the *Lusitania*, the saving in weight of machinery is shown to be immaterial; the saving in coal and wages, however, is considerable. The second case discussed is that of a 500 horse-power tramp steamer now in process of conversion to electric propulsion on the Paragon system. The new Bailey system of turbo-electric propulsion is described by H. C. Leake. Ordinary three-phase generators and squirrel-cage motors are used, and speed variation of the propelling motors is obtained by varying the speed of the turbo-generators. To enable the motors to be reversed, braking drums, mounted on the turbine shafts, are employed, which may be described as a species of turbine designed to absorb power instead of to produce it. Lieut. W. P. Sillince discusses the application of the Diesel engine to marine propulsion. Following a general outline of the construction, economy, etc., of the Diesel engine and its present employment in boats, Lieut. Sillince describes the Mirrlees system of electro-mechanical propulsion. Generators direct coupled to Mirrlees-Diesel engines are used. For speeds between full speed and half speed a combination friction and positive clutch couples together the engine and propeller shafts. For speeds below half speed the shafts are disconnected and motors are used.

Turning now to the employment of electricity for purposes other than propulsion, A. G. Collis summarizes former and present specifications for switchboards for warships, and criticizes the lack of uniformity in design. It is essential that manufacturers entering this field of work should specialize. It is also highly desirable, he urges, that parts of gear should be interchangeable even if made by different makers. The wiring of ships is treated by G. Austin. After enumerating the uses to which electricity is put on board ship and the various cir-

cuits that are desirable, Mr. Austin discusses the question of the most suitable voltage, and the various systems of wiring that may be used—single wiring, concentric and double wiring. The wires may be protected by wood casing, tubes, lead sheathing or armoring. Twin cable has much to recommend it. The insulation of wiring is rendered difficult by condensation and by the inevitable presence of salt. Careful erection is most important. Distribution may be on the system in which each light has its own fuse, or on that in which each group has a fuse; the latter appears to be sufficient. Owing to the special conditions, bell wires, as well as those for supply, should have good insulation. Mr. Austin contributes also a paper on ship illumination and fittings, in which he discusses the character of lighting and fittings suitable for decks, cargo holds, cattle spaces, emigrant accommodation, seamen's and officers' quarters, passengers' cabins, dining saloons, lounges, drawing rooms and smoking rooms, signal lamps and navigation lamp indicator. He shows the necessity of paying particular attention to insulation and the prevention of trouble by vibration. Illumination is further considered in a paper on searchlight projectors for marine purposes by E. A. Holmes, who describes various types of mirrors, methods of testing, systems of arc production, and accessory devices.

Two papers are devoted to electrical communication. The first, on ships' telephones, by H. S. Thompson, describes the general scheme adopted on board a ship, which, from the telephone point of view, may be looked upon as a large hotel. The instruments and other details, such as wiring and protection from stray currents, are considered. Owing to the special conditions at sea, such installations differ materially from those on land. For connecting a ship to a shore exchange, a special flexible cable, with connecting boxes is used. Wireless telegraphy for marine inter-communication is discussed by W. W. Bradfield. He outlines the advantages and progress of wireless telegraphy for marine purposes, and describes in detail the transmitting, receiving and emergency apparatus of the Marconi plant used on board ship. In conclusion, particulars are given of the number of naval and mercantile marine stations in operation in the various countries.

A paper is included on electrically driven shipyard cranes. The author, H. H. Broughton, first considers briefly certain details which affect the performance of all types of electric cranes. In the second part of his article descriptions are given of several cranes and crane systems in use in a number of the principal shipyards; these include yard cranes, building-slip equipment and fitting-out basin cranes.

One of the most interesting of the articles is James A. Seager's general discussion of the use of electric power for auxiliary purposes on board ship. The chief causes which militate against its adoption, he says, are the lack, in most cases, of definite specifications for the plant required, the ignorance of marine engineers of electrical matters, the lack of skilled attention, the desirability of simplicity of equipment, and the cutting of prices. The voltage used is preferably low for safety, but the use of electric power tends to raise the standard adopted. Although there is a tendency to run all auxiliaries electrically, it is safer to have some of them independent of the electrical plant. To a large extent the adoption of electrical auxiliaries resolves itself into a question of first cost *versus* running cost. Mr. Seager concludes his article with a reference to examples of auxiliaries now in use, and emphasis is laid upon the necessity for good workmanship and ample size of plant for the requirements.

Electric steering gear is the only auxiliary to which a special paper is devoted. A. P. Chalkley describes a number of systems of electrical steering, in particular those of the A. E. G., Pfatischer, Siemens Brothers, Clarke, Chapman & Co., and Brown Brothers. Mr. Chalkley contributes also an estimate of the future of electricity on ships. He points out that two tendencies are now apparent—either to use electricity for all purposes, or to apply it to every

purpose except that of propulsion. For generating purposes it is important to bear in mind the possibilities of the Diesel engine. Producer plant has also been suggested, but the future in this line seems doubtful. On the other hand, the position of the turbine is assured. The standard voltage shows a tendency to rise, and there is much to be said in favor of alternating current in preference to continuous. A marked advance may be expected in electrical steering gear. Generally speaking, Mr. Chalkley concludes, it may be said that the outlook for electricity on ships is very promising.

THE CUTTING PROPERTIES OF TOOL STEEL.

AN INVESTIGATION OF THE FACTORS INFLUENCING THE DURABILITY OF CUTTING TOOLS.

Edward G. Herbert—Iron and Steel Institute.

COMMENTING editorially on a paper on the cutting properties of tool steel, read by Edward G. Herbert at the recent meeting of the Iron and Steel Institute, *The Engineer*, London, says that no more remarkable contribution to the literature of the subject has been made since the publication of Taylor's voluminous monograph, "The Art of Cutting Metals." Mr. Herbert's experiments were made on a novel form of testing machine, invented by himself, which we have already described in these columns.* It will be recalled that in this machine a steel tube, ¾ inch in diameter and 1/16 inch thick, rendered of a uniform hardness throughout by suitable heat treatment, is revolved in a vertical position at a suitable speed, and is thrust against a cutting tool by a predetermined weight. The tool is carried in a steelyard and a micrometer shows the amount by which it wears away as it cuts the face of the tube. An autographic apparatus records the rate at which the tube is shortened by the tool, and an electric alarm gives warning when a standard degree of bluntness has been reached. The machine offers facilities whereby all the conditions of a cutting test can be regulated and kept constant, and it is possible, therefore, to obtain with it truly comparable results.

We gave in our previous review of Mr. Herbert's work some of the results of his earlier investigations. His purpose throughout has been thoroughly practical—to discover the conditions of metal cutting determining the best workshop results. "The best steel," he says, "is not the one which will keep its edge longest when run at a low speed, nor even the one which will remove the greatest amount of metal without becoming blunt. The engineer usually requires the steel that will remove the greatest amount of metal per hour without requiring too frequent sharpening." One of the most striking of Mr. Herbert's discoveries was the fact that the durability of all steels without exception is very low at low speeds (under light cuts), and that the durability of the cutting edge increases as the speed is raised. The research reported in his present paper is an investigation of the cause of the difference in the durability of the cutting edge of a given steel at different speeds, and of the changes in the physical condition of the steel which correspond to these changes in durability. The results appear fully to justify the conclusion indicated at the close of our previous review—that the durability of a cutting tool is almost entirely dependent on the rate at which heat is generated in cutting.

Mr. Herbert's argument is as follows: A decrease in durability with increased cutting speed might be very simply explained by saying that we are dealing merely with the rubbing of metal against metal, and that the increased wear at the higher speeds is due to the increased severity of the rubbing. But when we find that an increase in the cutting speed is actually accompanied by an increase in the durability of the tool, that this durability attains a maximum at a cer-

* THE ENGINEERING MAGAZINE, August, 1909.

tain speed, which is different for steels of different chemical composition, and that the durability then declines as the speed is further increased, it becomes evident that the durability of the cutting edge cannot depend simply on the rubbing of metal against metal. It may, however, depend on that which results from the rubbing, namely, the evolution of heat and the consequent rise in the temperature of the cutting edge, a rise which naturally becomes greater as the speed increases. Assuming this to be the case, we find that the durability or wear-resisting property of all tool steels is relatively low at normal atmospheric temperatures, that it increases as the temperature rises, attains a maximum at a certain temperature (depending on the composition of the steel), and declines as the temperature is further raised.

This theory Mr. Herbert has tested both by varying the temperature of the cutting edge by increasing the depth of cut taken at a constant speed, and by varying the temperature by the application of artificial heat to the tool, by causing hot water to circulate through the test tube of the testing machine, in place of the cold water normally used in durability tests. The results given in the paper appear to establish the heat theory of the durability of cutting tools working under the special conditions of the tool-steel testing machine. Its validity under workshop conditions is tested by means of Taylor's results. Mr. Herbert deduces from theoretical considerations a law of constant temperature in terms of feed, speed and depth of cut, which may be expressed by the equation

$$S_2 = S_1 \sqrt[3]{\frac{t_1 a_1}{t_2 a_2}}$$

or in words: For constant durability of the cutting tool, the speed varies inversely as the cube root of the product of area of cut and thickness of shaving. According to hypothesis, this law of constant temperature should be also a law of constant durability. That it is so is definitely established by comparison of data obtained by calculation from the cube law with the results of Taylor's shop durability tests.

There is already an accumulation of confirmatory evidence of the validity of the heat theory of durability from the workshop side. It is a matter of common experience, for example, that a tool stands up better if it is put in the fire immediately before being set to work, so that it "starts warm." Further, in quite a number of workshop operations it has been found possible to increase the durability of the cuting tool by increasing the cutting speed, although such an increase of speed goes against the instincts of the average workman.

Most of the speed, or temperature-durability, curves examined by Mr. Herbert have a simple form, rising to a point of maximum durability and then falling towards zero durability as the speed is raised. Some curves, however, a number of which are shown in the paper, have two points of maximum durability and a very distinct depression between them. This phenomenon is exceedingly common and is not confined to any one class of steel; the double-peaked curve has been obtained from carbon, tungsten, and tungsten-vanadium steels. Experience shows that the depression may occur at any point in the curve of any steel, and that its position varies according to the particular treatment the steel has received in hardening. The depression or dimple in the speed curve is perhaps the most remarkable fact brought to light by the tool-steel testing machine. The phenomenon is so marked—amounting sometimes to an almost total loss of durability at a particular speed which may be intermediate between two speeds, each of which gives the tool the highest durability of which it is capable—that it is almost incredible that it should have entirely escaped observation in the thousands of cutting operations of everyday practice. There is a good deal of evidence that the phenomenon exhibited in the speed curve is one which has been frequently observed in practice, though its precise character has never been suspected. Unaccountable failures of cutting tools are among the commonest of workshop experiences, and may be frequently due to working at the critical temperature of

low durability. To cite only one example, it is frequently observed that a tool, soon after being set to work, apparently fails—it becomes blunted to some extent; but if it is allowed to continue cutting, it "builds up," it recovers its durability, and may continue cutting for a considerable time without further loss of sharpness.

The second purpose of Mr. Herbert's research, to determine the changes in the physical condition of steel which correspond to the changes in durability, remains to be considered. Many experiments have been made on carbon, tungsten, and tungsten-vanadium steels to ascertain in what manner the durability of a tool is affected by its temper, percentage of carbon, and the cooling process to which it has been subjected. Detailed results are given in the paper. We may quote from Mr. Herbert's summary of the conclusions so far established: "Taking a general review of the results put forward, it is clear that the three classes of steel experimented with are all capable of producing either a single- or a double-peaked curve. The second or high-speed peak is strongly developed in high-speed and carbon steels which have been quickly cooled. The first or low-speed peak is developed in high-speed steel by slow cooling, and in the case of carbon steel by tempering at a high temperature. The effect of tempering high-speed steels has not been determined.

"A moderate rate of cooling, or in carbon steels a moderate tempering, produces a double-peaked curve, the steel having great durability at both low and high speeds, but very little durability at some intermediate speeds. The curve of the tungsten-vanadium steel differs essentially from that of the tungsten steel similarly treated, but whether this is generally characteristic of the two classes of steel, or peculiar to the particular brands used in the experiments, has not yet been determined. Salt-bath hardening seems to be generally beneficial in the case of tools intended for high-temperature cutting.

"No plausible hypothesis can yet be offered in explanation of the peculiar changes in the durability of steels; indeed, we have yet to determine what constitutes durability. It cannot be mere hardness, since there is no increase of hardness at increasing temperatures corresponding to the increasing durability shown by the rise of the left-hand portion of the speed curve. It seems more probable that this first increase of durability is due to a decrease of brittleness—a stronger coherence of the molecules as the temperature is raised. The decrease of durability shown by the descending portion of the curve may be due to an actual softening or tempering of the steel by the heat generated in cutting. The decrease of durability corresponding to the depression in the double-peaked curve can scarcely be due to a tempering process, since the steel could not in that case be expected to regain its durability at higher temperatures. This temporary loss of durability may, however, be due to an increase of brittleness occurring at certain temperatures. If this can be established by means of breaking tests on hot specimens of steel which have been so treated as to give a double-peaked curve on the tool-steel testing machine, it should not be difficult to establish a partial temperature scale corresponding to the testing-machine scale of cutting speeds.

"Nothing has been said about the relation between the speeds used in the tests and the corresponding speeds appropriate to any given set of actual working conditions. This relation cannot be established by direct application of the cube law, since this takes no account of the shape of the cutting tool and the hardness of the material operated upon. In the absence of any means of measuring actual cutting temperatures, the relation can only be established by making a complete speed curve in the lathe under ordinary working conditions, and comparing this with the curve made from the same tool on the testing machine. By preference, the tool chosen should be one which gives a double-peaked curve, since it would in that case be possible to correlate three distinct points on the curves, two maxima and a minimum."

A COMPARISON OF LATHE HEADSTOCK CHARACTERISTICS.

A METHOD OF ANALYSIS OF SPEED-TORQUE RELATIONS FOR THE USE OF DESIGNER AND PURCHASER.

Walter Rautenstrauch—American Society of Mechanical Engineers.

PROGRESS in the development of high-speed steels and the rapid accumulation of authentic experimental data of their properties and capabilities have reacted to a marked degree on machine-tool design. Charles Day has given in this Magazine* a number of examples of radical changes in tool construction designed to promote efficiency by limiting tool duty and by introducing characteristics adapting the machines to the most efficient use of the new steels. At a time when new designs are frequently offered and improvements are constantly added to existing types, it is important that the purchaser of machine tools should have a ready means of determining the suitability of a machine to his peculiar conditions; this Walter Rautenstrauch has supplied in a paper on the scientific analysis of lathe headstock characteristics, read before the American Society of Mechanical Engineers and printed in the *Journal* for June.

Since the new steels will take heavier cuts than is possible with carbon steels and still retain their durability, Prof. Rautenstrauch takes as the basis of his standard of comparison those characteristics of speed and torque in a lathe headstock which permit the most economical removal of shavings from soft and medium steels. The method of comparing the speeds and torques actually obtainable in any machine with the standard characteristics, for the purpose of judging the efficiency of the headstock, is that devised by Dr. J. T. Nicholson. The considerations on which the Nicholson method is based are as follows: "Since the volume of metal removed by a lathe tool in a given time is a product of the area of cut and the speed of cutting, the weight removed in one minute will be equal to the area of cut in square inches times the speed of cutting in inches per minute times the weight of the metal per cubic inch. The force on the tool has been determined experimentally to be approximately proportional to the area of the cut, the torque required to take any size cut is equal to the force on the tool times the radius of the work, and the speed at which the cut can be taken on any diameter of work depends on the spindle speed which can be obtained. These facts, together with the relations which have been established between possible maximum cutting speed and area of cut on different materials, show that in any machine a definite relation must exist between the spindle speeds and the accompanying torques obtainable, that the machine may be adaptable to efficient weight removal on all diameters of any material."

The approximate relation between the area of cut and the maximum cutting speed for soft and medium steel is expressed by Dr. Nicholson in the equation:

$$V = \frac{1}{a} + 15$$

where V is the cutting speed in feet per minute, and a the area of cut in square inches. From this equation may be determined the cutting speed at which it is possible to operate on these materials without injury to the tool, when taking a cut of a given size. To establish a basis for determining the spindle speeds and torques required to remove the maximum weight of shavings on all diameters of work, it is necessary to determine the average area of cut which a lathe of given size should be expected to take. Through correspondence with lathe builders, Dr. Nicholson learned that a widely accepted rule for the machining of mild steel forgings is

$$a = \frac{S^2}{25{,}600}$$

*THE ENGINEERING MAGAZINE, July and August, 1909.

where a is the area of cut in square inches, and S the swing of the lathe in inches.

Assuming that these relations are true, and in addition that the force on the tool varies directly as the area of the cut (for mild steel the force on the tool is approximately 100 tons for each square inch of area cut), an 18-inch lathe capable of removing the maximum weight of shavings in a given time on all diameters of work would have the following characteristics: standard area of cut on all diameters, 0.0126 square inch; force on tool, 2,520 pounds; torque on work of face-plate diameter, 1,890 foot pounds; maximum cutting speed, 94.5 feet per minute; revolutions of spindle required for this speed on work of face-plate diameter, 20 per minute. When the standard area of cut is taken on a smaller diameter the resulting torque will obviously be less. It will be necessary, however, to increase the spindle speed, if the speed giving most efficient use of the tool and constancy of volume of metal removed is to be maintained.

The spindle speed for these conditions will vary inversely as the diameter of the work and the torque directly as the diameter of the work. It is obvious, therefore, that when the problem is to remove the maximum weight of shavings on all diameters of work, the product of speed and torque should be a constant. The highest spindle speed for which a lathe should be designed will depend on the smallest diameter of work which the lathe can economically handle, and the maximum cutting speed desirable on this diameter. Assuming that the least diameter is $S/16$, and that a cutting speed of 120 feet per minute should be provided, the maximum spindle speed should be approximately $7{,}200/S$.

From these data a curve may be plotted showing the ideal characteristics towards which the design of a lathe should tend. The abscissae represent torques, and the ordinates revolutions of the spindle. The points representing the combinations of torque and spindle speed for work of face-plate diameter, and for work of the smallest size which can be handled economically are first plotted. An equilateral hyperbola between these points (since the product of speed and torque should be a constant) shows the proper relations of torque and spindle speed required to remove the maximum weight of shavings in a given time on all diameters of work of any given material.

This ideal diagram can be used either in design or as a means of determining the extent to which the speeds and torques of a lathe already designed correspond to the standard established. By its use it is possible also to determine whether or not any speeds, with their corresponding torques, might be omitted without affecting the weight-removing capacity of the headstock. Prof. Rautenstrauch describes in detail the method of using the diagram as a standard of comparison. It is possible here only very briefly to indicate the scope of his discussion. Speed and torque data for thirteen lathes of various swings and by different makers, taken from the manufacturers' catalogues, are plotted in characteristic curves. By reference to the ideal diagram it is shown wherein the designs are deficient, and examples are worked out showing the limits which improper headstock design imposes on either the area or the speed of the cut which can be taken on any diameter of work, and the extent to which the various speeds, with their corresponding torques, contribute to the weight-removing capacity of the lathes. As an illustration of how the relative merits of lathes of different makes may be determined with reference to a common standard, the diagram is used to demonstrate the uselessness of certain speeds, with their corresponding torques, possible in a number of the lathes selected. This analysis shows the striking difference of opinion existing among lathe builders as to what constitutes a sufficient powering of the lathe to meet the demands of the high-speed steels, the number of speeds to be furnished, and the spacing of the speeds and torques.

An analysis of this sort shows two things: first, that increasing the number of speeds without regard to the torque does not necessarily increase adaptability to economic performance; and

second, that the amount by which the efficiency can be increased does not increase in direct proportion to the additional number of speed changes provided, even if the accompanying torques are properly determined. The question of increasing efficiency by the introduction of additional speed-torque changes involves a solution of the problem whether or not the increase in efficiency warrants the increase in cost due to the additional equipment, and whether the management of the shop is such as to insure proper use of the additional equipment. Another use for this method of analysis particularly applying to design is the estimation of the beneficial effects of motor equipment on the efficiency of the machine. It affords a simple means of determining the changes which can be effected by applying direct motor drive, when the motor has certain characteristics of speeds and torques, to any particular machine with certain possible speed-torque combinations. The method is one, Prof. Rautenstrauch believes, which will materially assist the designer in determining justifiable speed-torque relations, and will enable the purchaser to determine whether or not the speed-torque characteristics of any given lathe are adaptable to his conditions.

THE ECONOMY OF THE EXHAUST STEAM TURBINE.

A COMPARISON OF THE FIRST AND OPERATING COSTS OF GAS ENGINE AND COMBINED STEAM ENGINE AND TURBINE PLANTS.

W. Heym—Die Turbine.

THE superior economy of the combination steam plant, utilizing the exhaust steam from reciprocating engines in low-pressure turbines, in comparison with plants equipped exclusively with either engines or turbines, is conclusively demonstrated by R. J. S. Pigott in his short series of articles on the revival of the reciprocating engine, concluded on another page of this issue. It is a remarkable fact that the belief is rapidly gaining ground that the combination steam plant is more economical than even the gas-engine plant. At full or nearly full load, and also at low power factor, the gas engine is a strong competitor of the steam engine or turbine. The first cost of the gas plant, particularly when operating on bituminous coal, is high, but the low fuel consumption and operating expense in most cases render the gas-power plant a more economical installation than either steam turbine or engine equipment. This superiority, however, does not persist to the same degree when the gas plant is compared with the combination steam plant. In fact, Herr W. Heym, who compares the first and operating costs of gas and combination steam plants in *Die Turbine* for March 5, finds the combination steam engine and turbine plant more economical within wide limits than the gas-engine installation.

Herr Heym takes the case of a 1,000-kilowatt plant of each type operating under similar conditions. Good steam coal is to be obtainable at from $1 to $3.50 per ton, an adequate supply of condenser water is available, and the cost of labor is to be that in good average practice. Each plant is to be in operation 24 hours per day, with a load factor of at least 20 per cent. At least one-third the total capacity of each plant is to be held in reserve.

A gas plant to meet these conditions will require three tandem, four-cycle, double-acting engine units, with producers and auxiliaries, connected to 500-kilowatt dynamos. For the steam plant it may be assumed that the low-pressure turbine working on exhaust steam is capable of delivering 80 per cent. of the power of the reciprocating engine running non-condensing. The turbine may be of the double-flow reaction type, or possibly, for such a small plant, a single-flow turbine with dummy piston. The mixed-pressure impulse turbine, with a high-pressure nozzle for using live steam during periods of overload, is also applicable. The turbine may be installed as an independent unit, with its

own governor, or it may be governed from the engine. At times of low load the turbine can be stopped altogether, and the engine made to exhaust directly into the condenser. A reserve Corliss engine is an advantage in case of accident to either engine or turbine.

The maximum capacity of the boiler plant must be such that in case of accident to the turbine, the two reciprocating engines can operate non-condensing. Assuming a maximum steam consumption of 30.8 pounds per kilowatt-hour under these conditions, the 1,000-kilowatt plant will require a boiler capacity of about 9,000 boiler horse power. These, however, are not the conditions of highest efficiency, and a boiler equipment of four 225 horse-power units (one reserve) will be sufficient for the plant. The boilers will be of the horizontal water-tube type and they will be equipped with economizers, mechanical stokers, internal superheaters, and all auxiliaries. Steam separators will be installed between engine and turbine and the equipment will be completed by a centrifugal jet condenser and a centrifugal dry-air vacuum pump.

Two Corliss compound engines, three three-phase dynamos with exciters and switch gear, and the boiler plant and accessories will cost about $87,500, or $87.50 per kilowatt. The turbo-generator with condenser and auxiliaries will cost about $22,500, or $50 per kilowatt, making the total first cost of the steam plant $110,000. The total cost of the gas plant, including the three engines, generators, exciters, producer plant, and all auxiliaries, will be $142,500, or $95 per kilowatt. The cost of buildings and foundations are not included in these estimates. The comparative first, maintenance and operating costs (exclusive of the cost of fuel) are shown in the following table.

TABLE I. FIRST, MAINTENANCE AND OPERATING COSTS OF 1,000-KILOWATT STEAM AND GAS PLANTS.

	Steam.	Gas.
Two 550-kilowatt steam engines, with dynamos, boilers and all steam and electric auxiliaries	$87,500	.....
One 450-kilowatt low-pressure turbine, with dynamo, condenser and all auxiliaries	22,500	.....
Three 500-kilowatt gas engines, with producers, dynamos, and all gas and electric auxiliaries	.....	$142,500
Total equipment cost	$110,000	$142,500
Interest on capital at 5 per cent	$5,500	$7,125
Maintenance and depreciation at 10 per cent	11,000	14,250
Labor at $7 per day for 365 days of 24 hours	2,555	2,555
Oil, waste, and supplies at $1.75 per day for 365 days of 24 hours	640	640
Total cost of maintenance and operation, exclusive of fuel	$19,695	$24,570
Total hourly plant cost, exclusive of fuel	$2.25	$2.80

The labor cost, estimated as the same for both plants, is made up as follows: one day engineer, $2.50; one night engineer, $2; and two stokers, $1.25 each, making the total $7 per day. Oil, waste, and supplies are estimated at $1.75 per day for each plant. Interest is computed at 5 per cent., and repairs and depreciation at 10 per cent., in the case of the steam plant, 11 per cent. for the engines and boilers, and 6 per cent. for the turbine. The load factor has practically no effect on these items of cost. The hourly costs of operation of the steam and gas plants, exclusive of the cost of fuel, are respectively $2.25 and $2.80.

Herr Heym discusses at length the question of fuel consumption, particularly in its relation to load factor. He assumes for the steam plant an evaporation of 4 pounds of water per pound of coal and an expansion from 11 atmospheres to 17.8 pounds pressure in the engine, and to 700 millimetres vacuum in the turbine, with a drop in pressure between engine and turbine of 1.1 pound. For the gas plant it is assumed that the load is very variable and that two engines are in operation the greater part of the time. Herr Heym gives curves showing the comparative fuel consumption per kilowatt-hour in the gas and steam plants at load factors from 20 to 100 per cent.; the fuel consumption of the steam plant is, of course, higher. Another set of curves, however, which

combine all elements of operating cost, the price of coal being taken at $3.50 per metric ton of 2,204 pounds, shows that with fuel at this price the steam plant is the more economical at all loads including and above 200 kilowatts, although the difference between the operating costs of the two plants decreases as the load factor increases.

A third series of curves shows the influence of fuel cost on the cost per kilowatt-hour at load factors of 20, 40, 60, 80 and 100 per cent. The greatest difference in cost is apparent at low fuel prices, the cost of power in the gas plant being higher at all load factors. As the price rises, the curves of cost per kilowatt-hour for gas and steam approach each and finally cross. The points of intersection are as follows: at 20 per cent. load factor, $6.75 per metric ton; 40 per cent., $8.50; 60 per cent., $8.75; 80 per cent., $4.25; and 100 per cent., $5. At these prices and load factors, the economy of the two plants is the same. At higher prices the gas plant is the more economical, and at lower prices the steam plant.

TABLE II. TOTAL YEARLY COST OF OPERATION AND MAINTENANCE.

Load Factor, Per Cent.	Steam.	Gas.	Difference.
100	$49,757	$51,009	$1,252
80	44,893	46,750	1,857
60	40,429	43,020	2,591
40	36,750	39,497	2,747
20	33,412	35,504	2,092

Table II gives the total operating cost per year of 8,760 hours for the two plants, exclusive of fixed charges, insurance and taxes on land and buildings, with coal at $3.50 per metric ton. Although the difference in cost per kilowatt-hour is greatest at 20 per cent. load factor, the table shows that the greatest total saving is at 40 per cent. load factor. The introduction of a cooling plant would increase the first cost of the steam plant by $10,750, and the annual operating cost by $1,075 (10 per cent.). Even with unfavorable condensing conditions, however, the steam plant will be more economical at 100 per cent. load factor by about $175 per year.

PROTECTIVE COATINGS FOR STRUCTURAL STEEL.

A REPORT OF EXPOSURE TESTS ON OVER FIVE HUNDRED DIFFERENT PAINTS.

Cloyd M. Chapman—American Society for Testing Materials.

FOR nearly four years past, the firm of Westinghouse, Church, Kerr & Co. has had in hand an investigation of the rust-preventing properties of protective coatings for structural steel. In all, over 1,600 tests have been made, on 530 different coatings, submitted by 271 manufacturers and dealers. The method of testing, and the results obtained, are now made public in a paper read by Cloyd M. Chapman at the recent meeting of the American Society for Testing Materials, from which we quote at length.

"The method employed in most of these tests was as follows: Small samples of the ready mixed paints were submitted by the manufacturer or dealer, together with a statement of the principal ingredients entering into their manufacture. Each paint was applied to two mild steel plates of about No. 16 gauge, 2 inches wide and 6 inches long, which had first been well cleaned of oil and foreign matter by rubbing with a cloth saturated with benzine. Each plate had its number plainly stamped in one corner. One plate was given one coat and the other two coats. Care was taken to give a uniform full coat to both sides and all edges of the plates. All painting was done indoors by the same person. About five days were allowed between coats for drying. After the second coat had dried the plates were fastened to boards with galvanized iron tacks and exposed on the roof at an angle of 45 degrees, facing south.

"On the day the plates were exposed scratch marks were made with a sharp instrument across two opposite corners of each plate. These scratch marks cut through the paint film, leaving bright metal exposed, so that rust could and did start immediately along these lines. At regular intervals after exposure each

plate was examined and a record made of its condition. The one quality which was being sought, and the prime factor which entered into the rating of the paints, was protection against rust.

"An arbitrary scale of ratings was adopted, based on the amount of rust apparent on the plate. Until some small spot of rust appeared the plate was rated at 100 per cent., except in cases of fading, alligatoring, bad chalking, etc., without any rust apparent, which were rated at 97 per cent. When one small spot of rust the size of a pinhead appeared the plate was rated at 90 per cent. When several such spots or one larger spot of rust appeared the plate was rated at 85 per cent. When the sum of the areas of the rust spots totaled an area of about ¼ inch square the plate was rated at 80 per cent.; when ½ inch square, at 75 per cent. When the combined area of rust spots totaled about 1 square inch the plate was rated at 70 per cent., and so on down the scale until zero rating indicates the plate entirely rusted on the exposed side. Examinations were made and results recorded at the end of two weeks, four weeks, six weeks, twelve weeks and every three months thereafter. . . .

"As noted above, each manufacturer was asked to state the principal ingredients in his paint, and on the basis of these statements each sample was placed in a group depending upon its chief pigment, or, in the absence of pigments, upon its vehicle. In this way the paints were divided into a number of classes as follows:

Carbons.—In this class are grouped the natural and artificial carbons, except graphite.

Graphites.—This class contains both the natural and artificial graphites.

Iron Oxides.—These also include both the natural and artificial pigments, some of which were received in paste or dry form, to which pure linseed oil was added in our laboratory.

Red Leads.—This class includes both the straight red lead and oil mixed in the laboratory shortly before applying, and the ready-mixed red lead paints which contain considerable percentages of other pigments to keep the lead in suspension. These red leads had no other coating over them.

Red Lead Primers.—These consist of tests in which the first coat was a red lead paint, either ready mixed or straight red lead and oil, while the second coat was of some other class. Of course, no one-coat tests could be made in this way. The second coats in this class were of widely different varieties.

White Leads.—This class is rather surprisingly small, and is made up largely of paints mixed from the paste in our own laboratory.

Zinc Oxides.—Few makers put out a zinc oxide paint for structural steel.

Mineral Hydrocarbons without Pigments.—This class is composed of paints made of the various kinds of tars and tarry refuse and the various minerals of an asphaltic nature, gilsonite, elaterite, etc., but without any pigments added to them. They form one of the more numerous groups, and as a rule are much lower priced than the oil paints. They also form the class for which the greatest merit is usually claimed by the makers and agents.

Mineral Hydrocarbons with Pigments.—This class is made up of the same character of materials as the last, but with various pigments added. For instance, a paint made of gas tar and iron oxide would fall in this class rather than in the iron oxide class.

Vegetable Hydrocarbons with and without Pigments.—This class includes distillates and residual pitches of vegetable oils, etc. They are not numerous enough to divide into two groups, hence those with and those without pigments are placed in the one class.

Cements.—Several manufacturers have acted upon the oft published statement of the fact that Portland cement offers a protection to steel against rust, and have put out a paint said to be made up largely of cement. These paints are here grouped in a class by themselves. As they have appeared in the market mostly within the past two years only one of them has had a full two years' exposure.

Chromates.—Another result of recent paint literature has been the appearance

of a number of paints said to contain chromates or chromic acid in some form. Some of these have appeared within the past year and no tests of those can be included in this paper.

Vehicles.—This class contains the oils, varnishes and transparent coatings containing little or no pigment, but which are more or less used for the protection of steel.

Miscellaneous.—Into this class are grouped all the coatings which do not fall into one of the above groups or concerning which the maker refused proper information to enable the paint to be classified. Other sub-divisions were made in our laboratory records, but they each contained so few representatives that they were all thrown into this miscellaneous class for purposes of comparison in this paper.

"In the following table is given a summary of the results obtained with each class of paints for one and two year exposures of one and two coat specimens. This table also gives in each case the number of tests which entered into each result:

TABLE OF RESULTS OF EXPOSURE TESTS OF STRUCTURAL STEEL PAINTS.

	One year exposure.				Two years exposure.			
	One coat.		Two coats.		One coat.		Two coats.	
Class.	No. of tests.	Average rating. Per cent.	No. of tests.	Average rating. Per cent.	No. of tests.	Average rating. Per cent.	No. of tests.	Average rating. Per cent.
Carbons	65	21	54	70	34	2	36	46
Graphites	67	18	56	66	42	3	43	45
Iron oxides	74	35	71	60	52	10	52	46
Red leads	50	58	39	77	19	16	20	61
Red lead primers	0	..	43	75	0	..	14	56
White leads	23	51	11	82	3	0	3	25
Zinc oxides	5	25	5	69	5	3	5	50
Mineral hydrocarbons without pigments	66	20	73	46	36	0	37	18
Mineral hydrocarbons with pigments	10	16	11	53	7	0	7	20
Vegetable hydrocarbons with and without pigments	13	19	13	57	3	0	3	5
Cements	7	36	7	46	1	0	1	0
Chromates	14	32	24	70	9	0	9	39
Vehicles	22	8	7	11	3	0	3	0
Miscellaneous	94	28	103	67	70	7	85	39

COMBUSTION IN CEMENT BURNING.

A CRITICISM OF THE ROTARY KILN, AND A SUGGESTION OF A TWO-KILN PROCESS GIVING MORE EFFICIENT HEAT UTILIZATION.

Byron E. Eldred—American Institute of Mining Engineers.

AMERICAN practice in cement burning, according to Byron E. Eldred, exhibits a remarkable crudeness in the application of the principles of combustion, and a no less striking lack of observation of the phenomena of combustion. In the course of a paper on combustion in cement burning, read before the American Institute of Mining Engineers in March and printed in the *Bulletin* for June, Mr. Eldred shows that efficiency of heat utilization in this and similar arts does not depend wholly on the thermal value of the fuel used. The form of the flame and the manner of the application of the heat to the object to be heated are matters of importance. Long-flame combustion and the application of the heating agent in contact with the work, he believes, will improve materially the economy of the cement-burning process. The plan proposed in Mr. Eldred's paper involves the separation of the process into two stages, calcining and clinkering, which are to be carried out in two separate furnaces.

"In the present practice of burning cement, the clinker is made by slowly passing a stream of finely powdered cement materials through a rotary kiln of from 5 to 8 feet internal diameter and from 60 to 150 feet long. In the entrance of the kiln burns an aerially supported flame plume, generally axially directed, produced by powdered coal injected by air. In passing through the kiln, the materials, which are an arti-

ficial or a natural mixture of clay and calcium carbonate, are first dehydrated by the heat of the flame gases. Then the carbonate is causticized by dissociation, or calcined, the carbon dioxide being driven off by heat, and finally the clay and lime unite to form the clinker.

"Each of these operations, dehydration, calcining, and clinkering, has different thermal requirements, and yet in the ordinary practice all three are performed by one flame: a flame particularly adapted to the needs of the clinkering operation and to that only. Clinkering requires a high temperature —a temperature sufficient to sinter the clay component and cause it to unite with the lime; but no great absorption of heat occurs; the action is exothermic. And as the calcines pass slowly under the blazing, heat-radiating coal flame, they rapidly acquire the necessary temperature and clinker. For the calcining, the waste heat of the flame gases is considered all that is necessary; yet the marked economy of the slow-burning, voluminous flame for calcining is well known in other arts.

"The net result is that the ordinary cement kiln is a good clinkerer, a highly inefficient calciner (the calcines often come into the clinkering zone with a material percentage of their carbon dioxide remaining), and a very wasteful thermal device." So far as combustion is concerned, the kiln is a horizontal flue, and, as in other horizontal flues, much gas stratification occurs. The gases from the flame, which is purposely spaced away from the work in the clinkering zone, rise into the arch of the kiln and never get into effective contact with the work in the calcining zone. Heating in the calcining zone is largely by radiation from the upper walls, and by direct conduction as the upper wall moves under the stream of material. Under the gases in the upper part of the kiln flows a current of relatively colder air, introduced partly by the stack suction and partly by the injector action of the flame and coal feeder.

Not only is the heating in the calcining zone inefficient; the calcination is performed under the worst possible conditions. It is a heat-absorbing reaction, and the carbon dioxide evolved, naturally a gas of high specific gravity, is relatively cold and dense, tending to remain in the bottom of the kiln as a separate stratum enveloping the material and very little admixed with the gases and air above. The carbonate is being calcined in an atmosphere at least abnormally rich in carbon dioxide, and as, within certain limits, the heat required to dissociate calcum carbonate is inversely proportional to the percentage of carbon dioxide in the atmosphere, it is easy to see why the rotary kiln is so poor a calciner in comparison with the vertical, separately fired lime kiln, in which the pieces of dissociating limestone are always bathed in a constantly changing atmosphere which can never contain more than 21 per cent. by volume of carbon dioxide, and which, as a matter of fact, never runs anywhere near as high as that amount. The sudden evolution of carbon dioxide from partially calcined material in the vicinity of the clinkering flame in the ordinary rotary kiln is the chief cause of the formation of clinker rings and nodules.

As a labor-saving device, the coal-fired rotary kiln was the greatest advance in the history of cement making; as a device for the utilization of heat, it is a grossly wasteful and inefficient apparatus. Theoretically, 25 pounds of coal should suffice for making a barrel of cement; the actual consumption is from 90 to 110 pounds. For a number of reasons, among them the transportation of dust by the gases and the necessity for unimpeded draft, it is not possible to improve heat utilization in the single kiln by the employment of regenerators, recuperators and like apparatus. The two defects of present practice in cement burning, imperfect calcination and inefficient heat utilization, can, however, be overcome by performing the two stages of calcining and clinkering as two stages in two kilns, using for each the combustion methods best adapted to the particular stage. This procedure permits the use of devices for heat recovery. The dust nuisance is obviated by the use of slow-traveling

flames in both steps; the high temperature gases from the clinkering operation can be used for regenerating the fuel for clinkering, and, though less practicably, the cooler gases from the calcining kiln for regenerating for that operation. The possibility of using regenerators permits the employment as fuel of producer gas in place of the more expensive powdered coal.

The severance of the calcining operation from dependence on the clinkering process introduces the possibility of scientific heat utilization in calcination. The process becomes a simple, lime-burning step, differing only from ordinary lime burning in that the finely powdered materials cannot be handled in a vertical kiln and thus brought into actual contact with the flame and hot gases by ordinary firing means. Fine material traveling down a rotary kiln requires, however, a type of flame different from that which proves satisfactory in the boiler furnace, a flame filling the cylinder and coming into actual contact with the material to be heated and burned, instead of traveling along its top. There are long-flame fuels, but few of them can be used economically in calcining cement materials, and fewer still will give a flame capable of filling the barrel of the kiln. The flame of ordinary good producer gas is too short and scanty; if it be burned with regenerated air, as heat economy dictates, it becomes still shorter. But the long, fat flame can be secured by the simple expedient of diluting the gas with a neutral gas, or, more simply still, by diluting the air used for combustion.

Air, diluent gas and combustible gas mixed in proper proportions, when passed through a kiln containing red-hot lime, will burn and will evolve heat. Under the laws of "wall action," the burning will be most intense where the gas is in actual contact with the hot solids. By dilution of the combustible gas or the air, the flame can be made as long and as voluminous as we please. Stack gases are better for diluting purposes than even pure nitrogen, because of the greater combustion-retarding action of the carbon dioxide. By a simple adjustment of the air valve and of the stack-gas valve, the flame may be made to lengthen and spread out until it fills the kiln. It does not burn at once and give gases rising into the arch; it burns all through the kiln, and most rapidly at the point where it comes into contact with the powdered refractory material of the cement mix. The calcination of the limestone takes place in flame gases, instead of in an atmosphere of nearly pure carbon dioxide. A slow draft current through the kiln can be employed, since it is not necessary to expel the products of combustion from a zone of intense heat to make room for fresh fuel. The calcination may be accomplished without regard to clinkering zone conditions, and regulation should secure a low temperature of chimney gases, which, under present practice, carry off approximately six times the heat of the discharged clinker. Practically half the waste heat accounted for in the chimney gases is carried by the excess air required to support the combustion of powdered fuel.

The heat required for the combination of the clinker is about 15 to 18 per cent. of the heat developed by the coal. The clinkering operation conducted in a separate kiln should require but little fuel and much less attention, as good clinker depends most largely on properly calcined material. Mr. Eldred proposes, therefore, for calcination, the present rotary kiln, gas fired, with long-flame combustion. Such a kiln has produced more than 6 pounds of lime per pound of coal burned in a producer with low fuel bed. The fritted calcines are to be taken from the calcining kilns to a special clinkering kiln, embodying heat regenerators and gas firing, the clinkering process being somewhat analagous to open-hearth practice. The two-kiln process has not yet been put into commercial operation, but Mr. Eldred works out an interesting heat balance from theoretical considerations. He reaches the conclusion that it should be possible to produce nearly 7.5 pounds of cement (lime, 68.55 per cent.; silica, 20.10 per cent.; alumina, 11.35 per cent.) per pound of coal.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING	Page 763	MECHANICAL ENGINEERING	Page 780
ELECTRICAL ENGINEERING	" 771	MINING AND METALLURGY	" 791
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CIVIL ENGINEERING.

BRIDGES.

Arches

Arch Coefficients. Transformation of Dimensions in Symmetrical Rib Arches; with Tables of Coefficients for Twenty Arches of Different Proportions. Malverd A. Howe. Mathematical. 2500 w. Eng News—June 2, 1910. No. 14513.

Foundations.

Foundations in the Rio Grande. George A. McKay. Explains conditions at Brownsville, Tex., in constructing a bridge across the Rio Grande, discussing the design of the foundations in quicksand. Ills. 4500 w. Harvard Engng Jour—May 1910. No. 14778 D.

Reconstruction.

Replacing a Short Truss Span by Plate Girders. Illustrates methods used on the Phila. & Read. R. R. in carrying out work without interrupting traffic. 500 w. Eng Rec—June 25, 1910. No. 15210.

See also Underpinning, under CONSTRUCTION.

We supply copies of these articles. See page 807.

Reinforced Concrete.

Methods and Cost of Constructing Three Short-Span, Single-Track Concrete Arch Bridges, Lake Champlain & Moriah Railroad. Gives methods and costs of constructing three reinforced-concrete arch bridges in northern New York. 800 w. Engng-Con—June 15, 1910. No. 14786.

Wide Span Ferro-Concrete Bridge in New Zealand. Illustrated description of a recently completed bridge in Auckland, with a span of 320 ft. 1200 w. Engr, Lond—June 17, 1910. No. 15243 A.

Recent Reinforced-Concrete Bridges (Neuere Eisenbeton-Brücken). The first part describes a single-span bridge at Kaltenthal. Ills. 1500 w. Deutsche Bau—May 25, 1910. No. 14882 B.

A New Reinforced-Concrete Bridge on the Moselle (Nuovo Ponte in Cemento armato sulla Mosella). Detailed description of a multispan arch bridge. Ills. Serial. 1st part. 5000 w. Il Cemento—May 30, 1910. No. 14851 D.

A Reinforced Concrete Bridge over the Spree at Lübben (Ponte in Cemento armato sulla Sprea a Lübben). Mathematical description of the design of truss. Ills. 2000 w. Il Cemento—May 15, 1910. No. 14849 D.

Steel.

An Early Specification for a Steel Bridge; the Glasgow Bridge Over the Missouri River. Information and general specifications for this bridge of the Chicago & Alton Ry., built in 1878. 3000 w. Eng News—June 2, 1910. No. 14511.

The Erection of the St. Paul's Missouri River Bridge. J. H. Prior. Illustrated detailed description of methods used in erecting a new bridge at Mobridge, S. Dak. 4000 w. Ry Age Gaz—June 10, 1910. No. 14681.

The Superstructure of the Mobridge Bridge on the Chicago, Milwaukee & St. Paul Railway. J. H. Prior. Drawings and detailed description of the structure and the methods of erection. Plate. 5500 w. Eng Rec—June 11, 1910. No. 14692.

Bellows Falls Arch Bridge. Joseph R. Worcester. Illustration, brief description, and information regarding this bridge across the Connecticut River. 2500 w. Jour Assn of Engng Socs—May, 1910. No. 15256 C.

The Nam-Ti Bridge. G. Bodin, in *Le Génie Civil.* Illustrated description of the bridge in Southern China, over the Nam-Ti River, and the peculiar methods employed in its construction. 1500 w. Sci Am—June 11, 1910. No. 14667.

Suspension.

Tyngs Island Bridge of the Vesper Country Club, Lowell, Mass. James W. Thomas. Illustrated description of a suspension foot bridge and its erection. General discussion. 6000 w. Jour Assn of Engng Socs—May, 1910. No. 15255 C.

Viaducts.

The Twentieth Street Viaduct, Denver, Colorado. Illustrated detailed description of a steel viaduct about 4407 ft. long. 2200 w. Eng Rec—June 4, 1910. No. 14571.

See also Elevated Railways, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS, and under STREET AND ELECTRIC RAILWAYS.

CONSTRUCTION.

Acoustics.

Architectural Acoustics. Wallace C. Sabine. A discussion of the possible effect of the motion of the air on the accoustical property of a room. 5000 w. Eng Rec—June 18, 1910. No. 14991.

Beams.

A General Criterion for Maximum Shear from a Train of Moving Loads. Lewis Jerome Johnson. A study of how to place a train of loads so as to produce a maximum shear at a given section of beam. Ills. 1500 w. Harvard Engng Jour—May, 1910. No. 14777 D.

Borings.

Uses and Methods of Preliminary Borings for Engineering Works. John P. Hogan. An illustrated account of methods, machines used, difficulties encountered, records, etc. 3000 w. Harvard Engng Jour—May, 1910. No. 14776 D.

Borings for the Panama R. R. Dock at Cristobal: With Table of Costs. E. B. Karnopp. Describes methods used, giving costs. Ills. 800 w. Eng News—June 16, 1910. No. 14906.

Coaling Towers.

A Reinforced-Concrete Locomotive Coaling Station of 2000 Tons Capacity. L. M. Ewell. Illustrated detailed description of a new coaling station in Philadelphia. 2500 w. Eng News—June 23, 1910. No. 15133.

Concrete.

Office Methods in a Concrete Designing Office. Describes the system and forms adopted by the Eastern Concrete Construction Company of Boston. 2500 w. Eng Rec—June 11, 1910. No. 14691.

The Construction of Concrete Fence Posts. Considers their advantages and making, and the principles involved. Ills. 9500 w. U S Dept of Agri—Farmers' Bul. 403. No. 14781 N.

The Use of Concrete in Farm Buildings from a Sanitary Standpoint. S. Cunningham, Jr. Discusses details of such buildings. 2200 w. Cement Age—June, 1910. No. 15041.

Concrete Features of the Toledo Filtration Plant. B. M. Baker. Brief description of this fine plant, especially the concrete features. Ills. 3500 w. Cement Age—June, 1910. No. 15040.

Concrete Mixers.

Concrete-Making Machinery. Vere Sus-

sex Hyde. Illustrations with description of the chief features of the principal machines being used in England. 2500 w. Surveyor—June 17, 1910. No. 15231 A.

Earthwork.

Earthwork Shrinkage, Application and Amount. E. B. Espenshade. Discusses how much earthwork shrinks and the comparison of excavation and embankment quantities. 2500 w. Engng-Con—June 1, 1910. No. 14552.

Economies.

Structural Economy. E. A. Slater. Suggests methods by which economies can be effected in various kinds of engineering work. 5000 w. Surveyor—June 3, 1910. No. 14738 A.

Factories.

Modern Factory Construction (Der moderne Fabriksbau). Joseph Aug. Lux. A plea for æsthetic treatment of factory structures. 2000 w. Oest Wochenschr f d Oeffent Baudienst—May 28, 1910. No. 15050 D.

Floors.

Concrete and Tile Floors, with Two-Way Reinforcement. Illustrated description of the Burchartz system, a new type of construction used in America, and brief notice of the Aragon system, used in France. 1200 w. Eng News—June 16, 1910. No. 14912.

Foundations.

The Ultimate Load on Pile Foundations: A Static Theory. John H. Griffith. Criticisms of the static method as it has been presented with an outline of views as to its development along rational and empirical lines. 10500 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14941 E.

Pneumatic Caisson Foundations, Whitehall Building, New York. Illustrated description of foundation work for a 32-story extension to a 20-story building. 3000 w. Eng Rec—June 18, 1910. No. 14996.

Artificial Foundations (Procédé de Fondation par Compression mécanique du Sol). P. Ossent. Describes the "Compressol" system of pile foundations. Ills. Serial. 1st part. 3200 w. Bul Tech d l Suisse Romande—May 25, 1910. No. 14833 D.

Pile Cutting.

Under-Water Pile Saw with Guide Bracket for Cutting to Even Grade. Clarence Coleman. Illustrated description of a pile-cutting machine used at Superior Entry, Wis. 800 w. Eng News—June 16, 1910. No. 14909.

Piling.

Pile Statics (Zur Frage der Pfahlstatik). A criticism of Herr Stern's recent paper by Herr Jacoby, with a reply by the former. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—May 14, 1910. No. 14898 D.

Piling and Trestling. F. R. Archibald. Read before the Nova Scotia Soc. of Engrs. Considers various kinds of piling, its uses and costs; deterioration; and temporary trestling. 2000 w. Can Engr—June 16, 1910. No. 14980.

Sheet Steel Piling. J. F. Springer. Illustrates and describes special forms of piling for aqueous construction, discussing early methods in the present number. 6000 w. Cassier's Mag—June, 1910. Serial. 1st part. No. 14841 B.

Reinforced Concrete.

A Few Notes on the Design of Reinforced Concrete. Considers points in practical building construction from the standpoint of the designer. 3000 w. Minn Engr—May, 1910. No. 14766 C.

Diagrams for Designing Reinforced Concrete Beams. Frank H. Carter. Diagrams, with explanatory notes. 700 w. Eng Rec—June 18, 1910. No. 14993.

A Graphical Chart for the Determination of Stresses in the Concrete and Reinforcement in Concrete Beams (Graphische Tabelle zur Ermittelung der Betonspannungen und der Eiseneinlagen in Eisenbetonunterzügen). Rob. Müller. Mathematical explanation of a chart based on the Prussian regulations. 1500 w. Deutsche Bau—May 14, 1910. No. 14881 B.

The Calculation of Stresses Due to Bending in Masonry and Reinforced-Concrete Structures (Beitrag zur Berechnung der Biegungsspannungen in Stein- und Betonkonstruktionen). W. Carling. A review of various theories. Ills. Serial. 1st part. 1200 w. Beton u Eisen—May 14, 1910. No. 15056 F.

Improving the Transverse Strength of Reinforced-Concrete Beams (Zur Aufnahme der Querkraft in Eisenbetonbalken). Herr Hotopp. Discusses the location of reinforcement for maximum strength. Ills. 3200 w. Beton u Eisen—May 14, 1910. No. 15055 F.

Construction of a Large Reinforced-Concrete Grandstand. The grandstand at the Minnesota State Fair race-track, St. Paul, is illustrated and its construction described. 2500 w. Eng Rec—June 4, 1910. No. 14572.

Multistory Frame Construction (Mehrstöckige Rahmenkonstruktionen). F. Baumstark. Mathematical. Ills. 3500 w. Beton u Eisen—May 14, 1910. No. 15051 F.

Reinforced-Concrete Construction in the Extension of the Bismarck Secondary School, Stettin (Die Eisenbetonkonstruktionen in dem Neubau der Bismarck-Realschule in Stettin). Herr Weidmann. Mathematical discussion of some of the construction details. Ills. 4000 w. Beton u Eisen—May 14, 1910. No. 15053 F.

See also Coaling Towers, under CONSTRUCTION; Siphons, and Tanks, under WATER SUPPLY; and Wharves, under WATERWAYS AND HARBORS.

We supply copies of these articles. See page 807.

Skyscrapers.

The New York Skycrapers. Thaddeus S. Dayton. Gives interesting facts regarding the era of tall buildings. 1800 w. Ir Age—June 16, 1910. No. 14900.

Steel.

The Calculation of Rolled Sections under the New German Regulations (Die Berechnung der Walzträger nach den neuen ministeriellen Bestimmungen). Herr Weidmann. Discusses particularly the effect of the new regulations on I-beam design. Ills. 2500 w. Stahl u Eisen—May 4, 1910. No. 14858 D.

Some Formulas for Statically Indeterminate Members and Frames. C. T. Mitchell. Gives formulas proposed as an aid in the analysis of moment stresses in single members or in rigid framed bents due to eccentric loading. 4000 w. Eng News—May 26, 1910. No. 14402.

The Design of Wall Bearings for H. S. Joists. T. McGill. Illustrated discussion of the length and area of bearing surfaces for beams or girders, the safe loads, etc. 1000 w. Prac Engr—May 20, 1910. Serial. 1st part. No. 14457 A.

A Narrow Twelve-Story Building. John S. Branne. Illustrates and describes a building in New York City, erected on a plot 22 ft. 3 ins. wide at one end and less than 20 ft. at the other. 1500 w. Eng News—May 26, 1910. No. 14404.

Tunnels.

The Metropolitan of Paris (Lé Metropolitain de Paris). P. Calfas. Describes the construction under the Seine of line No. 4, in which both the shield and freezing methods were used. Ills. 5000 w. Génie Civil—May 21, 1910. No. 14840 D.

See also same title, under WATER SUPPLY.

Underpinning.

Shoring Channel Span, South 22d Street Bridge, Pittsburg. Describes conditions that made necessary the replacing of river piers, and gives illustrated description of methods of supporting the superstructure. 2500 w. Eng Rec—May 28, 1910. No. 14414.

Waterproofing.

Waterproofing of Engineering Structures. Joseph H. O'Brien. Presents points of general interest and describes waterproofing by use of pitch and felt. Ills. Discussion. 7000 w. Jour Assn of Engng Socs—May, 1910. No. 15257 C.

Wrecking.

Wrecking the Gillender Building, New York. An illustrated account of the wrecking of a tall, steel-frame building in New York City. 1800 w. Eng Rec—June 11, 1910. No. 14689.

MATERIALS OF CONSTRUCTION.

Cement.

The New German Standard Specifications for Cement. H. Burchartz. Gives the requirements. Ills. 3500 w. Eng Rec—June 25, 1910. No. 15209.

A Microscopic Study of an Italian Natural Portland Cement (Studio Microscopico di un Portland naturale Italiano). Silvio Bosio. Illustrated with microphotographs. Serial. 1st part. 2700 w. Il Cemento—May 15, 1910. No. 14850 D.

Concrete.

Engineering Work in Concrete. Day Allen Willey. Illustrated review of the extending uses of this material in construction work. 4500 w. Cassier's Mag—June, 1910. No. 14639 B.

"What Are the Facts Respecting the Disintegration of Concrete by Sea Water, Alkali, Sewage, Etc." Summary of what is known in regard to this subject. 2500 w. Engng-Con—June 15, 1910. No. 14785.

Reinforced Concrete.

The Formation of Cracks in Reinforced Concrete (Einiges zur Rissbildung des Eisenbetons). Otto Graf. A discussion of the causes of cracks. Ills. Serial. 1st part. 2000 w. Beton u Eisen—May 14, 1910. No. 15052 F.

Steel.

The Application of Steel in Building Construction (Die Verwendung von Eisen im Hochbau). Herr Fischmann. Discusses steel sections, cost of materials, the structural-steel trade, etc. Ills. 1000 w. Stahl u Eisen—May 11, 1910. No. 14861 D.

Stucco.

Modern Stucco Work. Albert Moyer. Information in regard to its application and the production of artistic effects. 2000 w. Eng Rec—June 18, 1910. No. 14994.

MEASUREMENT.

Hydrographic Surveying.

The U. S. Lake Survey. M. S. MacDiarmid. Describes the work and methods. The main object being to prepare accurate navigator's charts. Ills. 2500 w. Cornell Civ Engr—June, 1910. No. 15043 C.

Surveying.

Methods and Costs of Railroad Surveys in Bolivia. C. A. Bock. Map and report of exploratory surveys and reconnoissance work. 3500 w. Eng Rec—June 25, 1910. No. 15206.

MUNICIPAL.

Barrow-in-Furness.

Barrow-in-Furness and Some of Its Municipal Undertakings. Arthur Race. Gives the principal industries, describing streets, street-lighting, refuse destructors, bridges, abattoirs, sewerage works, etc. Ills. 9000 w. Surveyor—June 10, 1910. Serial. 1st part. No. 15034 A.

City Planning.

Corey: Model City from the Ground Up. Albert Phenis. An illustrated description of a city being built in Alabama, to furnish healthful homes for the steel workers and allied industries. 2500 w. Mfrs' Rec—June 2, 1910. No. 14494.

Drainage.

The Glarus Drainage Works (Die Kanalisation der Stadt Glarus). H. Schleich.

We supply copies of these articles. See page 807.

Describes a storm-water drainage system. Ills. 3200 w. Schweiz Bau—May 14, 1910. No. 14883 B.

Pavements.

Influence of Tramways on Street Paving. R. O. Wynne-Roberts. Discusses the points in tramway and pavement construction that are of importance to road engineers. 5000 w. Surveyor—May 27, 1910. No. 14612 A.

Brick Paved Highways. W. P. Blair. Read before the Nat. Brick Mfrs. Assn. Discusses the proper construction. Ills. 3500 w. Munic Engng—June, 1910. No. 14926 C.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Gives a general description of the results obtained in some of the large towns of England by utilizing heat from refuse destruction. 1800 w. Munic Engng—June, 1910. No. 14924 C.

The Design and Working of a Modern Refuse Destructor. William F. Loveday. Gives a summary of the essential principles of refuse destructor design and describes a recent installation in England. 2000 w. Eng News—June 23, 1910. No. 15132.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Road Rollers.

Road Rollers Driven by Combustion Motors (Note sur les Rouleaux Compresseurs avec Moteurs à Mélange tonnant). M. Bret. Discusses their economy and advantages over steam rollers. Ills. 6000 w. Ann d Ponts et Chaussées—1910—II. No. 14804 E + F.

Roads.

Width of Roads. F. W. W. Doane. Discusses the unnecessary width of country roads and town streets. 2000 w. Can Engr—June 23, 1910. No. 15195.

Sand-Clay Roads. How to make good country roads on sand or clay soil. 2000 w. Munic Jour & Engr—June 15, 1910. No. 14783.

Road Construction and Maintenance. R. F. Grantham. A discussion of modern practice in construction, surface-treatment, requirements of new traffic, and related subjects. 4000 w. Surveyor—May 20, 1910. No. 14460 A.

The Management and Improvement of Rural District Roads. E. K. Dixon. Read before the Irish Road Cong. Discusses administration methods and suggests improvements. 3500 w. Surveyor—June 17, 1910. No. 15232 A.

The Need for Good Roads in the South. Lawrence C. Witten. Reviews the good roads movement in a number of southern states. 3000 w. Mfrs' Rec—June 23, 1910. No. 15109.

Road Work in Newton, Massachusetts. Edwin H. Rogers. Illustrates and describes methods of dust laying and roadway surfacing, giving costs of various treatments. 1800 w. Munic Jour & Engr—June 15, 1910. No. 14784.

Road Treatment in Eastern Massachusetts. Illustrated account of methods, costs, and apparatus used. 5500 w. Munic Jour & Engr—June 15, 1910. No. 14782.

The Waterproofing of Road Surfaces. George W. Manning. Read before the Inc. Assn. of Munic. & Co. Engrs. Deals only with highways, discussing the applications of various materials. 2000 w. Surveyor—May 20, 1910. No. 14459 A.

A Few Remarks in Regard to Surface-Spraying of Roads with Tar and Making in Situ Tar-Macadam. T. Aitken. Discusses the benefits resulting, the methods to ensure success, cost, etc. 2200 w. Surveyor—May 20, 1910. No. 14458 A.

Sewage Disposal.

Individual Sewage Purification Plant. Shows a combined septic tank and filter which requires very little attention. 1700 w. Met Work—June 18, 1910. No. 14964.

Degree of Purification of Sewage by Screens and Grit Tanks and Methods and Costs of Purifying Sewage to Higher Degree Than by Fine Screens. From notes supplementing the report on the Disposal of Sewage of the City of Rochester, N. Y., made by E. Kuichling. 5000 w. Engng-Con—June 22, 1910. No. 15123.

Reports on the Disposal of the Sewage of the Calumet District of Chicago and Its Relation to the Chicago Drainage Canal. Abstract of the report of the Committee on Engineering, with letters. Also editorial 6000 w. Eng News—June 16, 1910. No. 14911.

Flushing the West Branch of Bubbly Creek, Chicago. Drainage from large sewers and some surface wash are received by this stream which has little or no current and is practically an open septic tank with a very long period of flow The arrangements for flushing are illustrated and described. 1600 w. Eng Rec—June 11, 1910. No. 14687.

A Short Treatise on the Sewage Disposal Plant of Baltimore City. G. J. Reguardt. Describes the character of the sewage and the processes to which it will be subjected. Ills. 2500 w. Cornell Civ Engr—June, 1910. No. 15045 C.

Sewerage and Sewage Disposal Works. Lichfield. W. B. Chancellor. Describes a plant using the continuous-flow filter and fixed spray distribution. 1500 w. Can Engr—May 27, 1910. No. 14488.

The New Sewerage System of Louisville, Ky. Diagram, map and general description. 3000 w. Engng-Con—June 8, 1910. No. 14656.

The Glasgow Main Drainage and Sewage Disposal Works. An account of the electrical features, including electric

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pumping, an electricity supply station, and special electrical plant for clearing the catchpit. Ills. 2200 w. Elect'n, Lond—June 3, 1910. No. 14731 A.

The New Sewage Experiment Station of the Massachusetts Institute of Technology. C.-E. A. Winslow, and Earle B. Phelps. Plan and description of the new plant at Old Harbor Point in Dorchester. Ills. 2200 w. Eng News—June 2, 1910. No. 14516.

Sewage Pumping.

Sewage Pumping Appliances. George T. Hammond. A statement of the principles of sewage pumping. 4000 w. Munic Jour & Engr—June 8, 1910. No. 14655.

Sewers.

Sewer Interceptors at Columbus. Julian Griggs. Explains the reason for constructing relief sewers, and gives illustrated description of the new gate interceptors. 1500 w. Munic Jour & Engr—June 1, 1910. No. 14493.

Drainage Improvement and Intercepting Sewer System for Syracuse, N. Y. Glenn D. Holmes. The substance of a lecture before the College of Civil Engng, Cornell University. Description of the work. Ills. 4000 w. Cornell Civ Engr—June, 1910. No. 15042 C.

Details of the Design of the Sewers of Louisville, Ky. Illustrates and describes interesting details of this extensive sewer work. 3500 w. Engng-Con—June 15, 1910. Serial. 1st part. No. 14787.

Stone Crushing.

A Modern Stone Crushing Plant of 600 Cu. Yds. Capacity Per Hour—Some Costs of Drilling, of Maintenance of Plant, and of Erecting Machinery. Illustrated description of a plant near Chicago, and information relating to its equipment and operation. 3000 w. Engng-Con—June 1, 1910. No. 14551.

A New Type of Stone Crusher. Illustrated description of the Symons disk crushing machine. 1000 w. Eng News—May 26, 1910. No. 14407.

Street Prolongation.

The Elongation of the Rue de Rennes, Paris, and the Project for an X Bridge Over the Seine (Le Prolongement de la Rue de Rennes, à Paris, et le Projet de Pont en X sur la Seine). E. Hénard. A discussion of traffic congestion in Paris and suggested means of improvement. Ills. 3500 w. Génie Civil—May 14, 1910. No. 14839 D.

Street Traffic.

Chicago Traffic Conditions in the Congested District. Extracts from a report showing how the problem was studied. 2000 w. Eng Rec—June 4, 1910. No. 14568.

WATER SUPPLY.

Aqueducts.

See Tunnels, under WATER SUPPLY.

Conduits.

See Dams, under WATER SUPPLY.

Dams.

Experiments with a Model of the Gatun Spillway. Edward C. Sherman. Explains the design and purpose of the spillway and gives illustrated description of the experiments made on the model. 1700 w. Eng Rec—June 4, 1910. No. 14567.

An Arch Dam Design for the Site of the Shoshone Dam. John S. Eastwood. A criticism of the design of this dam, based on a description by H. N. Savage, and describing a proposed arch design. Ills. 2500 w. Eng News—June 9, 1910. No. 14666.

Dams with Overhung Batter. Robert H. Smith. Mathematical demonstration to show the erroneousness of the idea that a dam is given greater stability by giving its face a positive batter. 2000 w. Engr, Lond—May 27, 1910. No. 14626 A.

Concrete Dam and Conduit. Illustrates and describes work in connection with the Maiden Creek water supply of Reading, Pa. 4800 w. Munic Jour & Engr—June 1, 1910. No. 14492.

Evaporation.

Records of Evaporation Obtained at 23 Different Stations in Various Parts of the United States. Advance summary of data thus far gathered by the Government. 1800 w. Eng News—June 16, 1910. No. 14908.

Filtration.

Mechanical Gravity Filters. W. H. Humphreys. Presidential address before the Assn. of Water Engrs. at York, Eng. General discussion of mechanical gravity filters, and report of the installation at the York water-works. 4000 w. Surveyor—June 3, 1910. No. 14739 A.

See also Concrete, under CONSTRUCTION.

Fire Protection.

Fire Fighting Without Fire Engines. Herbert T. Wade. Illustrated description of methods and applications of the high-pressure fire service. 1700 w. Sci Am—June 4, 1910. No. 14505.

Ground Waters.

The Utilization of Ground Water, with Special Reference to the Rand Water Board's Wells in the Dolomite. D. C. Leitch. Considers the Transvaal law in respect to ground water, and describes the works, and location of the wells. Ills. 7000 w. Jour S African Assn of Engrs—April, 1910. No. 14606 F.

Preliminary Investigations for the Increase of the Czernowitz Water Supply (Die Vorarbeiten für die Erweiterung der Wasserversorgung der Stadt Czernowitz). G. Thiem. Describes an investigation of ground-water supplies. Ills. 5000 w. Oest Wochenschr f d Oeffent Baudienst—May 14, 1910. No. 14897 D.

Illinois.

Chemical and Biological Survey of the Waters of Illinois. Report for year ending Dec. 31, 1908, which includes a brief

description of work done during the year, and articles describing work at the laboratories, of difficulties with incrustation, investigations of farm water supplies and other subjects. Ills. 48000 w. Univ of Ill. Bul—Sept. 13, 1909. No. 14647 N.

Intakes.

Two Power-Plant Intakes at St. Louis. Notes from a paper by John Hunter, before the N. E. L. A. concerning the Ashley St. and Lewis St. intakes. Ills. 3000 w. Eng Rec—June 25, 1910. No. 15207.

Cooling-Water Intakes from the Mississippi River for Two Power Stations. John Hunter. From a paper before the Nat. Elec. Lgt. Assn. Illustrated description of the condenser supply systems of the two power stations of the Union Elec. Lgt. & Power Co. on the west bank of the river at St. Louis. 3000 w. Eng News—June 9, 1910. No. 14662.

Irrigation.

Field Work in Locating Irrigation Ditch and Canal Lines. Albert B. Bartlett. Describes methods used in the design of irrigating systems. 2000 w. Eng News—May 26, 1910. No. 14403.

The Cost of U. S. Reclamation Works. A statement before the House Committee on Irrigation by Director F. H. Newell of the U. S. Reclamation Service. 3300 w. Eng Rec—June 11, 1910. No. 14695.

An Example of Irrigation in Texas. H. V. Watts. Describes the irrigation system of San Benito. 2500 w. Mfrs' Rec—June 2, 1910. No. 14495.

Engineering Progress in Egypt and the Soudan. An outline of the progress of public works, based on the report of Sir Eldon Gorst. 1200 w. Engr, Lond—May 20, 1910. No. 14474 A.

London.

The Metropolitan Water Supply. E. Bailey-Denton. A discussion of the London water supply. 2000 w. Engr, Lond—June 17, 1910. No. 15241 A.

Pipe Laying.

Laying a 48-Inch Main Under Water. Illustrated description of the laying of this large main under the Harlem River, connecting Manhattan and the Bronx. 600 w. Pro Age—June 15, 1910. No. 14762.

Purification.

The Disinfection of Polluted Water. Clyde Potts. Discusses especially the use of chlorine for this purpose. 2200 w. Cornell Civ Engr—June, 1910. No. 15044 C.

Use of Hypochlorite in Connection with Pre-Filtration. Francis D. West. Describes an incompleted test to demonstrate that hypochlorite is not a panacea for all "water ills." 1200 w. Eng Rec—June 25, 1910. No. 15208.

Report on the Lindsay Ozone Water Purification Plant. Information from a recent report published by the Provincial Government of Ontario. Ills. 2000 w. Can Engr—June 3, 1910. No. 14591.

Reservoirs.

Reinforced Concrete Reservoirs. J. B. Henson. Read before the Northern Engng. Inst. (N. S. W.). Describes the Pelow Main reservoir and the Neath reservoir (N. S. W.). Diagram. 2000 w. Aust Min Stand—May 4, 1910. No. 14602 B.

The Western High-Service Reservoir of the Water Works of Baltimore, Md. Alfred M. Quick. Explains conditions and gives illustrated detailed description of a new reservoir of about 210,000,000 gals. capacity. 4500 w. Eng News—May 26, 1910. No. 14400.

Siphons.

A Method of Design of a Reinforced Concrete Siphon. J. Ralph Van Duyne. States the conditions and gives diagrams and description of method used. 2500 w. Eng Rec—May 28, 1910. No. 14418.

Sterilization.

The Sterilization of Water by Means of Chloride of Lime (La Stérilisation de l'Eau d'Alimentation au Moyen du Chlorure de Chaux). G. Dupont. Describes the plant and practice at Montreal, Canada. Ills. 3000 w. Génie Civil—May 7, 1910. No. 14836 D.

Swimming Pools.

Water Supply to a Swimming Pool. Illustrates and describes features of water purification and heating at John Jacob Astor's estate at Rhinebeck, N. Y. 2500 w. Met Work—June 25, 1910. No. 15193.

Tanks.

Perpendicular Reinforcement of the Walls of Cylindrical Tanks (Die lotrechte Bewehrung der Zylindrischen Behälterwand). Max Mayer. Mathematical, developing formulae. Ills. 3500 w. Beton u Eisen—May 14, 1910. No. 15054 F.

Tunnels.

Report on the Proposed Board of Water-Supply Pressure Tunnel Beneath New York City. Brief historical account of the project, with presentation of estimates and discussion of this and other distribution plans. 4000 w. Eng News—June 2, 1910. No. 14517.

The Moodna Pressure Tunnel of the Catskill Aqueduct. Illustrated description of its construction and power plant. 3000 w. Eng Rec—June 4, 1910. No. 14570.

The New Buffalo Water-Works Tunnel. F. Lavis. Illustrated description of methods of driving and lining a hard rock tunnel under compressed air. Also editorial. 6500 w. Eng Rec—June 25, 1910. No. 15204.

Typhoid.

The Maidstone Typhoid Epidemic. William P. Mason. An account of a serious typhoid epidemic in England, and its cause. Ills. 1200 w. Jour N Eng W-Wks Assn—June, 1910. No. 14937 F.

Water-Works Depreciation.

Depreciation in Water-Works Accounts. With Reference to Uniform Re-

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ports. Harvey S. Chase. Discusses the computation of depreciation and the best way to handle these matters. General discussion. 9000 w. Jour N Eng W-Wks Assn—June, 1910. No. 14938.

Water-Works Valuation.

Decision of the Railroad Commission of Wisconsin in the Appleton Water-Works Case. Discusses the subject of deriving fair valuations of such properties. 4000 w. Eng News—June 16, 1910. No. 14910.

Wells.

A Deep Well Sunk by Caisson. Illustrated description of a deep well to furnish domestic water supply at Long Beach, Long Island, N. Y. 1000 w. Eng Rec—May 28, 1910. No. 14416.

WATERWAYS AND HARBORS.

Barge Canal.

The Terminals of the New York State Barge Canal; Preliminary Report of the Terminal Commission. The preliminary report of the Commission appointed by the Legislature to investigate the matter. 900 w. Eng News—May 26, 1910. No. 14408.

The New York State Barge Canal. An illustrated description of the general design of the canal and the structures upon it, with a brief account of the progress of the work. 6500 w. Eng News—June 9, 1910. No. 14661.

Breakwaters.

Breakwaters at Vornpör and Hanstholm, Jutland. Illustrated description of recently constructed breakwaters for the protection of fishermen and to prolong the fishing season. 1800 w. Engng—May 27, 1910. No. 14617 A.

Canals.

The Stockton, California, Diverting Canal. An account of an improvement to prevent silting of a navigable channel, and also to prevent floods. 1500 w. Eng Rec—June 18, 1910. No. 14992.

Coaling Stations.

The Naval Coaling Station at Tiburon, California. Illustrated description of a Double-deck structure having a capacity of about 500 tons per hour. 1200 w. Eng Rec—May 28, 1910. No. 14421.

Docks.

Pontoon Method of Subaqueous Concrete Construction. Photographs, diagrams, and brief description of method adopted at Goderich, Ont., for dock extension. 500 w. Can Engr—June 10, 1910. No. 14685.

A Modern Type of Dock Construction. Harrison L. Garner. Illustrated detailed description of the construction of a reinforced-concrete dock on the Chicago river. 1800 w. Wis Engr—June, 1910. No. 14928 D.

The East Boston Docks. Howard K. Alden. Illustrated description of the Boston & Albany Railroad improvements. 1500 w. Harvard Engng Jour—May, 1910. No. 14780 D.

Flood Prevention.

See Canals, under WATERWAYS AND HARBORS.

Georgian Bay Canal.

The Georgian Bay Ship Canal. Map and information concerning the proposed canal to furnish a shorter route between the Great Lakes and the St. Lawrence River. 3000 w. Engng—May 20, 1910. No. 14464 A.

International Waterways.

A Treaty for the Control of International Waterways. Gives the provisions of most interest to engineers in the "Waterways Treaty" between the United States and Great Britain, for fixing the international boundary between the United States and Canada, and for determining the disposition of all boundary differences. 800 w. Eng News—June 9, 1910. No. 14659.

Lighthouses.

Building the Miah Maul Shoal Lighthouse. Thomas J. Rout, Jr., and A. E. Arledge. Illustrated detailed description, and general information concerning this lighthouse in Delaware Bay. 1800 w. Eng News—June 2, 1910. No. 14510.

Method of Lighthouse Illumination (Différents Modes d'Eclairage des Phares). M. J. Bénard. An exhaustive consideration of lamps, searchlights, reflectors, projectors, etc. Ills. 14000 w. Mem Soc Ing Civ de France—March, 1910. No. 14810 G.

Locks.

The Operation of Locks with Lateral Reservoirs (Wie kann bei Schleusen mit Sparbecken der Betrieb beschleunigt werden?). E. Beyerhaus. Suggestions for securing more rapid operation. Ills. 3200 w. Zeitschr d Oest Ing u Arch Ver—May 27, 1910. No. 14896 D.

Panama Canal.

Present Conditions at Panama. A review of progress made in the construction of the ship canal, with map, profile, cross-sections and illustrations. 2800 w. Engr, Lond—May 27, 1910. Serial. 1st part. No. 14623 A.

Piers.

Reinforced Concrete Pier Construction. Eugene Klapp. Illustrated detailed description of a private yacht pier, built near Glen Cove, Long Island. 2500 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14939 E.

Concrete Piers, Port of Genoa. Brief description of interesting repair work recently completed. 600 w. Engng—May 20, 1910. No. 14469 A.

Pollution.

The Metropolitan Sewerage Commission Against the Discharge of Treated Passaic Valley Sewage Into New York Bay. A report addressed to the Mayor of the City of New York, with editorial crit-

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icism. 2500 w. Eng News—June 9, 1910. No. 14660.

Rotterdam.

The New Waterway to Rotterdam 1879-1908 (Der neue Wasserweg nach Rotterdam 1879 bis 1908). A. von Horn. A review of the developments of the last thirty years. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—May 21, 1910. No. 14899 D.

Russia.

Interior Navigation in Russia (La Navigation intérieur en Russie). M. Bourgougnon. A report of the discussion at the Inter. Navigation Congress, St. Petersburg, 1908. Ills. 8800 w. Ann d Ponts et Chaussées—1910-II. No. 14806 E + F.

Russian Mercantile Harbors (Ports de Commerce de la Russie). M. G. de Joly. A review of the harbors and harbor works, traffic, administration, etc. Ills. 8500 w. Ann d Ponts et Chaussés—1910-II. No. 14807 E + F.

Silt.

The Silt Problem: Kaw River. Herman Stabler and Horatio N. Parker. A study of this river in Kansas as an illustration of methods that may be used to avoid large errors in the solution of engineering problems. 2000 w. Eng News—June 2, 1910. No. 14514.

Sluice Gates.

Some Notes on Sliding Sluice Gates, Charles River Basin, Boston -Cambridge, Mass. Walton H. Sears. A record of the Commission's experience to date with the cast-iron bronze-faced gates installed. Ills. 1800 w. Eng News—May 26, 1910. No. 14406.

Soerabaja.

The Harbor of Soerabaja (Het Havenplan voor Soerabaja). J. Kraus and C. J. de Jongh. Two short papers on this important port in Java. Ills. 5000 w. De Ingenieur—May 28, 1910. No. 15083 D.

Tacoma.

Commencement Bay, the Harbor of Tacoma. Louis P. Zimmerman. Fifth of series of articles describing the principal harbors of the Pacific coast. Ills. 4000 w. Marine Rev—June, 1910. No. 14969.

Water Powers.

The Effect of Recent Engineering Progress in Reducing the Value of Water Power. Editorial, showing the importance of correct understanding of the value of water-power, discussing the advantages of the steam-turbine electric station over the hydro-electric station, and the difficulties and limiting conditions of water-power plants. 3000 w. Eng News—June 23, 1910. No. 15134.

Governmental Regulation of Water Powers. Marshall O. Leighton. Reviews some European legislation bearing on water-power control. Discussion. 7000 w. Jour N Eng W-Wks Assn—June, 1910. No. 14935 F.

The Economic Importance of the Austrian Alpine Water Powers (Die kaufmännische Bedeutung der österreichischen Alpenwasserkräfte, ihre Rentabilität, Finanzierung und Besteuerung). Walter Conrad. A discussion of economical and rational methods of utilization. Ills. Serial. 1st part. 5000 w. Elektrotech u Maschinenbau—May 29, 1910. No. 15070 D.

Wharfs.

A New Reinforced-Concrete Wharf on the Guadalquivir, near Seville (Nouvel Appontement en Béton armé sur le Guadalquivir près de Séville, Espagne). Juan Manuel de Zafra. Describes a trestle wharf for the shipment of 2,000 tons of ore per day. Ills. 3500 w. Génie Civil—May 14, 1910. No. 14838 D.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

New Wireless Telegraphy and Telephony Instruments. Illustrated description of the Helsby instruments and account of the recent demonstration at the Crystal Palace, London. 2000 w. Engr, Lond—May 27, 1910. No. 14627 A.

The Helsby Wireless Telegraph and Telephone Systems. Brief illustrated description of apparatus used. 400 w. Elect'n, Lond—May 27, 1910. No. 14609 A.

Some Experiments with the New Telefunken System. Graf Arco. Describes a number of experiments and shows how messages from two sending stations can simultaneously be picked up by one receiver. Ills. 2500 w. Elect'n, Lond—June 10, 1910. No. 15031 A.

Wireless Telegraphy for Marine Inter-Communication. W. W. Bradfield. Discusses the advantages, and gives illustrated detailed description of the various parts of the Marconi plant used on board ship. 3500 w. Elect'n, Lond—June 10, 1910. No. 15029 A.

Radiotelegraphy Masts.

Erection of an 80-Metre Timber Mast and Tests on Doubled and Reinforced Timber Beams (Errichtung von 80 m hohen Holzmasten und Versuche mit verdübelten und verstärkten Balken). Herr Lengeling. Describes the construction and erection of the mast. The beam tests were on a number of bridge members made by combining two parts of the same section and reinforced in various ways. Ills. 4000 w. Glasers Ann—May 1, 1910. No. 14890 D.

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Telephone Rates.

The Typical Rate Problem in Small Telephone Properties. Frank F. Fowle. The present number gives statistics and information relating to "Independent" development. 1000 w. Elec Rev, N Y—June 4, 1910. Serial. 1st part. No. 14583.

Telephonic Stethoscope.

A Telephonic Stethoscope. Illustrates and describes an interesting device invented by S. G. Brown. 1700 w. Sci Am—June 18, 1910. No. 14914.

Telephony.

The Telephone Industry of the World. Gives statistics showing the United States far in the lead of all countries. 2000 w. Elec Rev, N Y—June 25, 1910. No. 15203.

Telephone Engineering Around the Golden Gate. Arthur Bessey Smith. An account of the engineering problems of Oakland and San Francisco, and how they were solved. Ills. 6000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14958 F.

Telephone Circuits. Prof. J. Perry. Read before the Phys. Soc. Gives an easy method of calculation for the spacing of Pupin coils. 3500 w. Elect'n, Lond—May 20, 1910. No. 14449 A.

The Telephone and Its Relation to Electric Tramways (Le Téléphone et ses Rapports avec les Tramways électriques). M. Henrion. A discussion of telephone systems utilizing tramway rails for the return current. Ills. 6000 w. Soc Belge d'Elecns—May, 1910. No. 14800 E.

See also Ships' Telephones, under MARINE AND NAVAL ENGINEERING.

DISTRIBUTION.

Fuses.

Standardization of Fuses. H. W. Kefford. Abstract of a paper read before the Inst. of Elec. Engrs. Discusses the most suitable quantitive and structural properties for a standard line of fuses. 6000 w. Elec Engr, Lond—May 27, 1910. No. 14608 A.

Industrial Plants.

Electrical Distribution of Energy in Industrial Plants. George R. Terry. Describes a system that has been adopted throughout several industrial mill properties. 1200 w. Elec Wld—June 23, 1910. No. 15140.

Wiring Conduits.

Strap-Iron Supports for Conduit. George S. Mason. Methods of erecting multiple conduit runs are illustrated and described. 1600 w. Elec Wld—June 2, 1910. No. 14504.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Synchronizing Alternators. S. G. Winn. Considers the operation of alternators in parallel. Ills. 2500 w. Cassier's Mag—June, 1910. No. 14640 B.

A. C. Motors.

Buying Alternating-Current Motors. H. M. Phillips. Suggestions for the selection of reliable motors. 3000 w. Elec Age—May, 1910. No. 14409.

Short-Circuit Losses in Alternating-Current Commutator Motors. A. Fraenckel, and B. J. M. Lane. Gives results of experimental researches on the losses due to the short-circuit currents. 1800 w. Elect'n, Lond—May 20, 1910. Serial. 1st part. No. 14450 A.

The Three-Phase Series Commutator Motor (Zur Theorie des Drehstrom-Serienkollektormotors). L. Dreyfus and F. Hillebrand. A theoretical discussion. Ills. 4500 w. Elektrotech u Maschinenbau—May 1, 1910. No. 15064 D.

Contribution to the Study of Asynchronous Motor by Means of the Circle Diagram (Contribution à l'Etude des Moteurs asynchrones par le Diagramme du Cercle). J. Yernaux. Mathematical. Ills. 1000 w. Soc Belge d'Elecns—May, 1910. No. 14801 E.

Bearings.

The Origin and Prevention of Currents in Bearings. L. Alder. Abstract from *Electrotechnik and Maschinenbau.* Discusses the causes of currents in the bearings of electric machines, and how the nuisance can be avoided. 2000 w. Elect'n, Lond—June 3, 1910. No. 14732 A.

Brushes.

Electrical Characteristics of Carbon Brushes. Jay L. Smith. Describes and shows graphically experimental results obtained from sample brushes. 2500 w. Sib Jour of Engng—June, 1910. No. 14934 C.

Cooling.

Air Filters for Turbodynamos (Luftfilter für Turbodynamos). K. Hoefer. A description of air-cooling devices. Ills. Serial. 1st part. 1000 w. Zeitschr f d Gesamte Turbinenwesen—May 30, 1910. No. 14880 D.

D. C. Dynamos.

Methods of Deriving the Neutral for Direct-Current Three-Wire Systems. James R. Werth, Jr. Read before the N. E. L. A. Compares the types of generating apparatus with particular reference to the method of deriving and controlling the neutral. 2500 w. Elec Age—June, 1910. No. 15108.

D. C. Turbo-Generators.

Direct-Current Turbo-Generators. W. L. Waters. From a paper before the Nat. Elec. Lgt. Assn. Considers factors in the design, and the constructions found satisfactory, referring to foreign practice. 2500 w. Eng News—June 9, 1910. No. 14665.

Induction Motors.

The Right Type of Induction Motor. R. H. Fenkhausen. Describes various types and their operating characteristics. Ills. 2000 w. Power—June 28, 1910. No. 15253.

Notes on the Operation and Testing of Polyphase Induction Motors. J. W. Rogers. 1500 w. Prac Engr—June 10, 1910. Serial. 1st part. No. 15033 A.

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The Theory of the Single-Phase Induction Motor (Theorie des Einphasen-Induktionsmotors). Fredrich Schmidt. A brief statement of the theory. Ills. 1200 w. Elektrotech u Maschinenbau—May 8, 1910. No. 15066 D.

Vector Diagrams.

A New Method of Representing Power and Energy in Vector Diagrams (Eine neue Darstellung von Leistung und Energie im Vektordiagramm). Franklin Punga. Mathematical demonstration. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—May 15, 1910. No. 15068 D.

Voltage Regulation.

The Voltage Control of Generators and Feeder Systems. F. W. Shackelford. Read before the N. E. L. A. Discusses only alternating-current systems, describing various regulators as applied to different systems. Ills. 3800 w. Elec Age—June, 1910. No. 15197.

Windings.

Winding of Dynamo-Electric Machines. I. Introductory. R. A. Smart. Considers the difference between a. c. and d. c. windings. II. Small Direct-Current Machines. G. I. Stadeker. Considers the threaded-in-from-the-reel type of winding. Ills. 4000 w. Elec Jour—June, 1910. No. 14771.

The Tractive Force Between Current-Carrying Wires and Coils (Ueber die mechanische Kraftwirkung zwischen stromdurchflossenen Leitern und Spulen). R. Czepek. Develops formulae for circular, square and rectangular coils and gives results of tests. Ills. 5000 w. Elektrotech u Maschinenbau—May 8, 1910. No. 15067 D.

ELECTRO-CHEMISTRY.

Electric Furnaces.

The Design of Furnace Electrodes. Carl Hering. Simple rules for proportioning the electrodes for minimum loss. Also editorial note. 3500 w. Elec Wld—June 16, 1910. No. 14798.

A New Resistor Furnace. F. A. J. FitzGerald. Illustrated description of a furnace heated by radiation from resistance. 500 w. Met & Chem Engng—June, 1910. No. 14633 C.

Electrochemical Society.

Pittsburgh Meeting of the American Electrochemical Society. Report of meeting, giving abstracts of papers read. 24000 w. Met & Chem Engng—June, 1910. No. 14636 C.

Electroplating.

An Electroplating Outfit. A. J. Jarman. Description, with practical working formulae. 2000 w. Sci Am—June 25, 1910. No. 15143.

Electrodeposition of Lead from Perchlorate Baths. Frank C. Mathers. Abstract of a paper before the Am. Elec.-Chem. Soc. Describes experiments with the lead perchlorate plating and refining bath. 1800 w. Brass Wld—June, 1910. No. 14721.

Nitrates.

Electrochemical Manufacture of Nitric Acid and Nitrates (La Fabrication de l'Acide nitrique et des Nitrates par l'Electrochimie). Th. Schlœsing. Describes the Birkeland and Eyde plant and process at Notodden, Norway. Ills. 6000 w. Tech Mod—May, 1910. No. 14826 D.

Review of 1909.

Progress in Electrochemistry in 1909 (Fortschritte der Elektrochemie im letzten Jahre). A review of electrochemical patents and literature. Serial. 1st part. 3300 w. Elektrochem Zeitschr—May, 1910. No. 14855 D.

ELECTRO-PHYSICS.

Arcs.

Relation Between Temperature of Electrodes and Voltage of the Electric Arc. C. D. Child. Abstract of an article in the *Phys. Rev.* A résumé of experimental researches which show that the cooling of a carbon arc raises the pressure several volts. 2200 w. Elect'n, Lond—June 3, 1910. No. 14734 A.

Electrostatic Experiments.

Electrification of Insulating Materials. W. Jamieson. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Brief account of investigations of the best kind of materials to use for producing electrification in a humid atmosphere. Short discussion. 1500 w. Elect'n, Lond—May 20, 1910. No. 14448 A.

Hysteresis.

Magnetic Hysteresis in a Rotating Field. M. G. Lloyd. Reviews information obtained by research in regard to rotary hysteresis. 1500 w. Elec Rev, N. Y—June 4, 1910. No. 14581.

Spark Gap.

Spark-Gap Phenomena. J. M'Whan. Abstract of paper read before the Roy. Soc. of Edinburgh. Describes phenomena observed in connection with a solid dielectric placed between the terminals of an induction coil or influence machine. 1700 w. Elect'n, Lond—May 20, 1910. No. 14451 A.

Thermo-Electric Properties.

The Thermo-Electric Properties of Alloys (Sur les Propriétés Thermo-électrique des Alliages). Witold Broniewski. A review of the progress of knowledge in this field, with bibliography. Ills. 7500 w. Rev de Métal—May, 1910. No. 14814 E + F.

GENERATING STATIONS.

Accumulators.

See Isolated Plants, under GENERATING STATIONS.

Central Stations.

The Generating System of an Electric Lighting Company. A. R. Cheyney. Considers briefly the important functions relating to the production of electricity. 8500 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14956 F.

We supply copies of these articles. See page 807.

Some Developments in Modern Lighting Systems. C. W. Stone. A brief review of modern developments that have changed the character of lighting stations. 4000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14952 F.

Southern California Developments. Del Reynolds. An illustrated account of the work undertaken by Huntington interests to give light, heat, power and transportation to Southern California. 2200 w. Pro Age—June 15, 1910. No. 14763.

Steam-Driven Transmission System. Illustrated description of plant for the supply of cheap electrical energy to mines in the Wisconsin zinc district. 4000 w. Elec Wld—June 16, 1910. No. 14795.

The Greenock Electricity Undertaking. Illustrated description of new works at Dellingburn Street, which combine a generating station and refuse destructor. 2500 w. Elec Rev, Lond—June 10, 1910. No. 15014 A.

A London Electric Supply Station. Illustrated detailed description of the features of interest in the new station in Horseferryroad. The ground floor serves as a power station and an upper story as a sub-station. 2500 w. Engr, Lond—May 27, 1910. Serial. 1st part. No. 14624 A.

New Generating Station of the Westminster Electric Supply Corporation. Plans and description of the station and its equipment. 2000 w. Elect'n, Lond—May 20, 1910. Serial. 1st part. No. 14447 A.

Marseilles' New Power Plant. Dr. Alfred Gradenwitz. Illustrated description of a recent installation having a capacity of 14000 kilowatts. 2000 w. Power—June 7, 1910. No. 14597.

See also Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Costs.

Operating Costs of Large Units. Information concerning the operating costs of the Commonwealth Edison Company's large turbine units in Chicago. Ills. 3000 w. Power—May 31, 1910. No. 14429.

Economics.

See Incandescent Lamps, under LIGHTING; and Electric, under MECHANICAL ENGINEERING, AUTOMOBILES.

Germany.

The Economic Importance of the Electricity-Supply Industry in Germany (Die wirtschaftliche Bedeutung der offentlichen Elektrizitätswerke Deutschlands). G. Dettmar. Gives elaborate statistics of the industry. Ills. 3000 w. Elek Kraft u Bahnen—May 14, 1910. No. 15060 D.

Hydro-Electric.

A General Review of Hydroelectric-Engineering Practice. Frank Koester. This fourth article of a series deals with generators, switchboards and electrical equipment. Ills. 3000 w. Engineering Magazine—July, 1910. No. 15259 B.

The Proposed Hydro-Electric Development at Coon Creek Rapids. A. C. Ringsred. An account of a proposed development on the upper Mississippi River. 2500 w. Minn Engr—May, 1910. No. 14765 C.

Housatonic River Hydroelectric Plants. J. Franz. Brief illustrated description of examples of early and modern methods of hydroelectric development. 1200 w. Elec Wld—June 2, 1910. No. 14500.

The McCall Ferry Hydro-Electric Plant on the Susquehanna River. Illustrated detailed description of the design and method of construction of a 135,000 horsepower station. 6000 w. Eng Rec—May 28, 1910. No. 14413.

The Hydroelectric Development of the Great Western Power Company. Illustrated detailed description of the design of this great scheme in California for furnishing power to Oroville, Marysville, Sacramento, Antioch, Oakland and intermediate towns. 3000 w. Eng Rec—June 11, 1910. Serial. 1st part. No. 14686.

Hydroelectric Development on the Niobrara River. W. K. Palmer. Illustrated description of a station near Valentine, Neb., for supplying energy to a projected 128-mile single-phase railway. 2500 w. Elec Wld—June 2, 1910. No. 14501.

Colorado Hydroelectric Installation. Illustrated description of the Glenwood generating station of the Central Colorado Power Co. 1700 w. Elec Wld—June 23, 1910. No. 15137.

Glenwood Hydroelectric Plant, Central Colorado Power Company. Illustrates and describes the hydraulic features of the first plant of an extensive system at Shoshone, near Glenwood. 4000 w. Eng Rec—June 25, 1910. No. 15205.

The Andelsbuch Hydro-Electric Plant near Bregenz (L'Usine hydro-électrique d'Andelsbuch prés de Bregenz). A. Bidault des chaumes. Illustrated description of this plant in the Tyrol. 2200 w. Génie Civil—May 7, 1910. No. 14834 D.

The Electrical Works of the Società Industriale Elettrica della Valnerina, Terni, Italy (Die Kraftübertragungsanlagen der Società Industriale Elettrica della Valnerina in Terni, Italien). L. Pasching. Illustrated description of the "La Cervara" power station. 4000 w. Elek Kraft u Bahnen—May 14, 1910. No. 15061 D.

See also Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

Isolated Plants and Central Station Current. E. Coleman Fay. Remarks on factors that must be considered, cost, reliability, etc. 1500 w. Eng Rec—June 18, 1910. No. 14998.

Investigations of Energy Supply for a Group of Manufacturers. Analysis of supply for a building containing 19 tenants manufacturing various commodities.

We supply copies of these articles. See page 807.

1800 w. Elec Wld—June 16, 1910. No. 14799.

Economical Small Electric Plants. Warren H. Miller. Illustrates and describes small plants in Europe showing remarkable engine economy. 2000 w. Elec Wld—June 2, 1910. No. 14502.

Electricity in Leather Manufacturing. Fred S. Sly. Illustrated description of the new power plant of the Pfister & Vogel Leather Co., Milwaukee, Wis. 2000 w. Elec Rev, N Y—June 18, 1910. No. 14989.

Operation of the Coast Artillery School Power Plant. Offnere Hope. Reports plant tests and analysis, and the operation, economy, etc. Ills. 7500 w. Jour U S Art—May-June, 1910. No. 14764 D.

A Palatial Steam Power Plant. A. R. Maujer. Illustrated description of the mechanical plant for furnishing heat, light, elevator service, etc., in Charles Schwab's New York residence. 1500 w. Power—June 28, 1910. No. 15250.

A Storage-Battery Extension to a Three-Phase Colliery Power-Plant. William Maurice. From a paper read before the Inst. of Min. Engrs. Explains the situation that demanded a supply of more power and how it was met. Ills. 1400 w. Col Guard—June 3, 1910. No. 14745 A.

Reliability.

Continuity of Supply in Modern Power Stations. H. I. Liwenz. Discusses the plant arrangement necessary to secure unbroken continuity of supply. 4500 w. Engr, Lond—May 20, 1910. No. 14476 A.

Switchboards.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Switchgear.

High-Tension Switchgear. A. G. Collis. Discusses recent practice in switchgear design and illustrates typical installations. 3500 w. Elect'n, Lond—June 3, 1910. No. 14735 A.

The Modern Oil Switch With Special Reference to Systems of Moderate Voltage and Large Ampere Capacity. A. R. Cheyney. Considers the type used in the large generating systems of cities, and also switchboard construction. 7500 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14960 F.

LIGHTING.

Illumination.

The Physical Production of Light. Edw. P. Hyde. A study of certain questions in physiological optics, discussing the laws of radiation and the radiating properties of metals. 8000 w. Jour Fr Inst—June, 1910. Serial. 1st part. No. 14921 D.

The Calculation of Illumination. C. Toone. States assumptions and explains method. 1500 w. Elec Rev, Lond—June 10, 1910. No. 15015 A.

Regulation and Illumination. L. B. Spinney. Read before the Iowa Elec. Assn. Gives tables and illumination curves showing the importance of good regulation. 2500 w. Elec Rev, N Y—June 4, 1910. No. 14582.

The Illumination of Very Large, High Rooms. Jas. R. Cravath. Illustrated description of the lighting equipment of a large track room and gymnasium. 2200 w. Elec Wld—June 23, 1910. No. 15141.

Incandescent Lamps.

Radiation from Metals. Edward P. Hyde. Abstract of paper before the Am. Phys. Soc. Discussion of investigations relating to the selection of metallic filament lamps. 2500 w. Elec Wld—June 23, 1910. No. 15139.

High Efficiency Lamps, Their Effect on the Cost of Light to the Central Station. S. E. Doane. Read before the N. E. L. A. Convention. Gives results of experience, observation, and analysis. 4800 w. Cent Sta—June, 1910. No. 14962.

Metal Filament Lamps. John W. Howell. Mainly a discussion of tungsten lamps and their advantages and the importance of lamp testing. 3000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14951 F.

A New Form of Tungsten Lamp. Charles F. Scott. From a paper read before the Nat. Elec. Lgt. Assn. Illustrated description of the "wire type" developed by the Westinghouse Lamp Co. 2500 w. Elec Jour—June, 1910. No. 14772.

See also Tungsten, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Lighthouses.

See same title, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Photometry.

Some Methods of Measuring Light. W. C. Philpott. Read before the Can. Gas Assn. Illustrated review of methods used and tests made. 2800 w. Am Gas Lgt Jour—June 27, 1910. No. 15213.

Searchlights.

Searchlight Projectors for Marine Purposes. E. A. Holmes. Illustrates and describes the type used and some special accessories. 1500 w. Elect'n, Lond—June 10, 1910. No. 15027 A.

Electric Military Searchlights (Les Projecteurs électriques Militaires). A. Bochet. A review of their development, describing modern types. Ills. 8000 w. Bul Soc Int d Elecns—May, 1910. No. 14808 F.

Street.

Factors That Should Be Considered in Making Street Lighting Contracts. S. M. Rust. Read before the Ohio Elec. Lgt. Assn. Discusses some of the more important factors. 1800 w. Munic Engng—June, 1910. No. 14925 C.

A High Efficiency Reflector for Street Lighting. Clayton H. Sharp. Abstract of a paper before the Ill. Engng. Soc. Illustrated description of a new form designed to give a more uniform illumination. 2500 w. Elect'n, Lond—June 17, 1910. No. 15228 A.

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MEASUREMENT.

Dynamo Testing.

The Determination of the Efficiency of Direct-Current Machines by the Hopkinson Test. C. V. Drysdale. Describes a simple method of carrying out the test. 1200 w. Elect'n, Lond—June 3, 1910. No. 14733 A.

Galvanometers.

The Einthoven Galvanometer (Le Galvanomètre Einthoven). H. Marchand. Description of a special type of galvanometer developed for the study of high-frequency currents. Ills. 1000 w. L'Elecn—May 21, 1910. No. 14822 D.

Oscillographs.

Determination of the Power of Alternating Currents from Oscillographs (Effektbestimmung von Wechselströmen aus Oszillogrammen). E. Behne. Mathematical demonstration of a simple graphical method. Ills. 1200 w. Elektrotech u Maschinenbau—May 1, 1910. No. 15065 D.

POWER APPLICATIONS.

Gas Works.

Electricity in French Gas Plant. Warren H. Miller. Illustrates and describes uses of electrical energy in the city of Paris gas works. 2800 w. Elec Wld—June 9, 1910. No. 14657.

Pumping.

See Electric Pumping, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

TRANSMISSION.

Alternating Current.

Symbolic Alternating-Current Equations. G. E. Marsh. A review of the general equations for expressing relations in a. c. circuits. 800 w. Elec Wld—June 16, 1910. No. 14796.

Application of Symbolic Equations. Harry P. Wood. The solution of problems involving star-connected three-phase circuits. 500 w. Elec Wld—June 16, 1910. No. 14797.

Earthing.

Earth Currents and Their Influence on Earthing (Ueber Erdströme und ihre Einflüsse auf die Erdung). E. Rühle. Discusses the best method of making earth connections. Ills. 2000 w. Elek Kraft u Bahnen—May 4, 1910. No. 15058 D.

Fault Location.

Localization of Faults on Underground Mains. W. A. Toppin. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Gives the results of the author's experience with a 3-wire direct-current system, describing a simple method of locating earth leakages without interrupting the supply. 2000 w. Mech Engr—May 20, 1910. No. 14462 A.

Insulators.

The Application of Porcelain to Strain Insulators. W. H. Kempton. Considers the advantages and disadvantages of porcelain for insulators, and reports tests made to secure data for use in insulator design. Discusses features of the design. Ills. 1800 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14953 F.

Lightning.

Atmospheric Electricity. Elihu Thomson. Abstract of an address at the formal opening of the Palmer Physical Laboratory, at Princeton University. A review of present knowledge on this subject. Ills. 5500 w. Sci Am Sup—June 18, 1910. No. 14915.

Lightning Protection.

Practical Means of Protecting the Insulators of High-Tension Lines Against Lightning and Excess Voltages (Praktische Massnahmen zum Schutze der Isolatoren von Hochspannungsleitungen gegen Blitzschlag und Starkstromübergang). W. Weicker. Describes various types of insulator design. Ills. 2300 w. Elek Kraft u Bahnen—May 24, 1910. No. 15063 D.

Line Construction.

Transmission Line Crossings of Railroad Rights-of-Way. Allen H. Babcock. Gives general specifications covering the points under discussion between the power and railroad companies. 1500 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14955 F.

Transmission-Line Crossings Over Railways. From the joint report of the Committee on Overhead Line Construction of the Nat. Elec. Lgt. Assn., and the Committee on Electricity of Am. Ry. Engng & Main. of Way Assn. 3000 w. Eng News—June 9, 1910. No. 14664.

Line Design.

Transmission Line Equations. C. P. Steinmetz. Derives the equations directly from line constants and discusses their accuracy. 700 w. Elec Wld—June 23, 1910. No. 15138.

Some Problems in Power Transmission. H. W. Buck. Read before the N.-E. L. A. Discusses towers, spans, insulators, conductors, voltage, regulation, frequency, etc. 2500 w. Elec Age—June, 1910. No. 15196.

Problems in Power Transmission. H. W. Buck. Abstract of paper read before the Nat. Elec. Lgt. Assn. Discusses the introduction of steel towers, the lengthening of the space, installation of conductors, voltage and its regulation, etc. 2500 w. Eng News—June 23, 1910. No. 15131.

New Ideas in Electrical Distribution Methods. S. B. Way. Read before the Nat. Elec. Lgt. Assn. Describes new ideas in construction and operation in St. Louis and vicinity. 2000 w. Eng News—June 9, 1910. No. 14663.

Live-Wire Indicators.

A New High-Tension Indicator (Ein neuer Hochspannungsanzeiger). Hermann Zipp. Describes a portable device for detecting live wires, for the use of linemen. Ills. 2000 w. Elek Kraft u Bahnen—May 4, 1910. No. 15059 D.

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Poles.

Reinforced Concrete Poles. Data and descriptions of different types of construction, taken from a paper prepared by Messrs. R. D. Coombs and C. L. Slocum. 2500 w. Eng Rec—June 18, 1910. No. 14997.

Transformers.

Modern Problems of Transformer Design. Louis F. Blume. Considers capacity, artificial cooling, materials used, etc. Ills. 2500 w. Sib Jour of Engng—June, 1910. No. 14932 C.

MISCELLANY.

Accidents.

Accidents Caused by Electrical Currents (Les Accidents causés par le Courant électrique). M. d'Arsonval. Discusses the effects of electric shocks, treatment, first-aid, tests to determine death, etc. 3800 w. Bul Soc Int d'Elecns—May, 1910. No. 14809 F.

Agriculture.

Electricity and Plant Growth (Versuche über Elektrokultur). Dr. Gerlach and Dr. Erlwein. A report of recent tests in Germany. Ills. Serial. 1st part. 1500 w. Elektrochem Zeitschr—May, 1910. No. 14854 D.

Austria.

The Austrian Electrical Industry in 1909 (Die elektrotechnische Industrie im Jahre 1909). Emil Honigmann. The first part discusses the slow development of the electrical industries in Austria and Hungary. Serial. 1st part. 3000 w. Elektrotech u Maschinenbau—May 22, 1910. No. 15069 D.

INDUSTRIAL ECONOMY.

Cost Systems.

Cost Accounting in Manufacturing (De Verrekening der "onkosten" in het Fabrieksbedrijf). K. G. Simon. A discussion of the principles and practice of cost determination. Ills. 8500 w. De Ingenieur —May 14, 1910. No. 15082 D.

Education.

Suggestions for the Education of a Civil Engineer. H. M. North. Discusses the aims and suggests some methods of attaining them. 4800 w. Wis Engr—June, 1910. No. 14927 D.

The Education of Mechanical Engineers (Ueber die Heranbildung der Ingenieure in mechanischen Betrieben). Johann Ritter v. Merkl. A discussion of conditions in Austria. 3500 w. Zeitschr d Oest Ing u Arch Ver—May 20, 1910. No. 14895 D.

Report of Committee on Industrial Education. P. Kreuzpointner. 4000 w. Am Found Assn—June, 1910. No. 15105 N.

The Training of Men—A Necessary Part of the Modern Factory System. Discussion of Magnus W. Alexander's paper on this subject. 5000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14949 F.

The Working of the Educational Bureau of the Union Pacific. Explains what this bureau is doing and how it is doing it. 5500 w. Ry Age Gaz—June 10, 1910. No. 14683.

Engineering English.

Standardization of English in Technical Literature. T. A. Rickard. A critical review of words improperly used. 7000 w. Inst of Min & Met, Bul 68—May 19, 1910. No. 14919 N.

Exhibitions.

The Brussels International Exhibition. Describes a number of the displays, including boiler accessories and fittings; heating and ventilating plants; agricultural and laundry machinery. 5000 w. Engng—June 3, 1910. Serial. 1st part. No. 14753 A.

Management.

The Twelve Principles of Efficiency. Harrington Emerson. This second article of a series shows by natural analogy, and contrast wherein efficiency organization differs from the old military type. 5500 w. Engineering Magazine—July, 1910. No. 15258 B.

Time Keeping and Labour Distribution in the Foundry. Victor R. Claydon. This third article of a series discusses simple methods for keeping down shop expenses. 2500 w. Engineering Magazine—July, 1910. No. 15262 B.

Scientific Factory Management. Holden A. Evans. Explains the aims of scientific management. 4500 w. Am Mach—Vol. 33. No. 24. No. 14791.

How the Foreman Can Promote Shop Efficiency. C. J. Drury. An article submitted in a prize competition. Also articles by E. T. Soidy and by Elmo N. Owen. 4000 w. Ry Age Gaz—June 3, 1910. No. 14542.

Patents.

Licenses to Work Patents. Remarks on English patent laws, especially explaining licenses to manufacture. 2200 w. Engr, Lond—June 17, 1910. No. 15237 A.

Prices.

The Cost of Living; Has It Risen, and Why? Alex. Del Mar. Discusses alleged and real causes and their proportionate effects. 4500 w. Engineering Magazine—July, 1910. No. 15264 B.

Publicity.

Publicity and French Industry (La Publicité et l'Industrie française). Octave Jacques Gérin. A discussion of the func-

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tion of publicity in industry and the best means of promoting it. Ills. 8000 w. Bul Soc d Encour—April, 1910. No. 14817 G.

Purchasing.

Organization of a Purchasing Department on Railroad Systems. Edward Norton Chilson. Aims to cover the important points with regard to the duties of the purchasing department and the methods of maintaining an efficient system. 4000 w. Jour of Acc—June, 1910. No. 14648 C.

Wage Systems.

The Law of December 7, 1909, Governing the Payment of Wages (La Loi du 7 Décembre 1909 sur le Payement des Salaires des Ouvriers et Employés). Maurice Bellom. A criticism of recent legislation in France. 2600 w. Génie Civil—May 21, 1910. No. 14842 D.

MARINE AND NAVAL ENGINEERING.

Barges.

Steel Barges for the Mississippi. Plan, section, and description of a type to be built for the transportation of steel products. 1000 w. Ir Age—June 9, 1910. No. 14653.

Reinforced Concrete Barges on the Pacific Division of the Panama Canal. Gives reasons for the use of reinforced concrete, and illustrates and describes the barges. 2000 w. Eng Rec—May 28, 1910. No. 14419.

Battleships.

Forty Years' Progress in the Displacement and Speed of Warships. Gives a list of representative British vessels of battleship and cruiser types for the last forty years, with the speed coefficient and h. p. per ton of displacement of each, discussing developments. 2000 w. Engr, Lond—June 3, 1910. No. 14757 A.

Increase in Displacement of Battleships since the Appearance of the Armored Cruiser (Deplacementssteigerungen der Linienschiffe seit Erscheinen der Hochseepanzerschiffe). Franz Eissenhardt. A review of recent tendencies in battleship design. 2500 w. Schiffbau—May 11, 1910. No. 14876 D.

The New Russian Battleships. Elevation and plans, with critical discussion of the designs. 2500 w. Engng—May 20, 1910. No. 14471 A.

Trials of the Brazilian Battleship "Sao Paulo." Report of trials, with illustration and information. 2500 w. Engng—June 3, 1910. No. 14754 A.

Compasses.

Compass Deviations. William C. Ward. Considers the behavior of the compass on iron and steel ships. 2000 w. Sci Am Sup—June 4, 1910. No. 14506.

Cruisers.

The Comparative Trials of the American Scouts. Reviews the recent report of the U. S. Navy Department on the trials of the Birmingham, Salem, and Chester. 1800 w. Engr, Lond—June 3, 1910. No. 14755 A.

The Brazilian Scout Cruisers. Illustrated detailed description of the Bahia and the Rio Grande do Sul, and their equipment. 3000 w. Engr, Lond—May 20, 1910. No. 14477 A.

Destroyers.

The Destroyer—Our Naval Weakness. Yates Stirling, Jr. Gives a brief sketch of the development of these vessels, and presents arguments to prove them necessary as a part of a fighting fleet. 4000 w. Pro U S Naval Inst—June, 1910. No. 15101 F.

The French Destroyer Voltigeur. Illustrated article giving information concerning the vessel and its equipment, and report of official trials. 2000 w. Engr, Lond—June 3, 1910. No. 14756 A.

Dredges.

Light-Draft Stern-Wheel Suction Dredge for Navigation Improvement on the Niger. States the requirements and gives an illustrated description of the vessel designed for the work. 1500 w. Eng News—June 16, 1910. No. 14905.

A Light-Draught Sand-Pump Dredger. Illustrated description of a dredger recently built for the improvement of the river Niger, explaining the conditions to be fulfilled. 1500 w. Engr, Lond—May 20, 1910. No. 14479 A.

Electric Power.

The Evolution of Electrical Engineering in the Navy. Discusses progress and describes the general layout of the electrical equipment. 4500 w. Elect'n, Lond—June 10, 1910. No. 15017 A.

The Future of Electricity on Ships. A. P. Chalkley. Shows a promising outlook, the tendencies being either to use it for all purposes, or to apply it to every purpose except propulsion. 3000 w. Elect'n, Lond—June 10, 1910. No. 15016 A.

Marine Propulsion by Electric Motors. Henry A. Mavor. Investigates a special case where the present method of driving is admittedly efficient and cheap, and discusses the subject generally. 3000 w. Elect'n,Lond—June 10, 1910. No. 15018A.

A System of Turbo-Electric Propulsion of Ships. H. C. Leake. Describes a system using ordinary three-phase generators and squirrel-cage motors. 3000 w. Elect'n, Lond—June 10, 1910. No. 15019 A.

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Electrical Marine Propulsion on the "Paragon" System. Wiliam P. Durtnall. Considers two cases in detail in which the effect is estimated of replacing the usual steam drive by the "Paragon" electric system. Ills. 5000 w. Elect'n, Lond—June 10, 1910. No. 15020 A.

Electro-Mechanical Propulsion with Diesel Engines. W. P. Sillince. Gives figures on the economy of the Diesel oil engine, and outlines the Mirrles system of electro-mechanical propulsion. Ills. 1200 w. Elect'n, Lond—June 10, 1910. No. 15021 A.

The Use of Electrical Power for Auxiliary Purposes on Board Ship. James A. Seager. Discusses the causes that are unfavorable to its adoption, and considers examples in use. 3500 w. Elect'n, Lond—June 10, 1910. No. 15030 A.

Switchboards on Warships. A. G. Collies. Summarizes former and present specifications and criticises the lack of uniformity in design. 2500 w. Elect'n, Lond—June 10, 1910. No. 15023 A.

Recent D. C. Turbogenerators with Special Reference to their Application on Shipboard (Neuere Gleichstrom-Turbogeneratoren mit besonderer Berücksichtigung ihrer Anwendung auf Schiffen). Fr. Heintzenberg. Discusses their application to ship propulsion and for lighting and power. Ills. 3200 w. Schiffbau—May 25, 1910. No. 14877 D.

See also Steering Gears, under MARINE AND NAVAL ENGINEERING.

Electric Wiring.

The Wiring of Ships. G. Austin. Discusses the question of the most suitable voltage, and the various systems of wiring that may be used. 6000 w. Elect'n, Lond—June 10, 1910. No. 15024 A.

Fireboats.

A New Fireboat for Seattle, Wash. M. H. Strouse. Illustrated detailed description of the "Duwamish," a powerful fireboat. 1800 w. Eng News—June 23, 1910. No. 15130.

Fire Boats David Scannel and Dennis T. Sullivan for San Francisco Harbor. Illustrated detailed description of these boats. 4000 w. Int Marine Engng—June, 1910. No. 14524 C.

The New Boston Fire Boat Engine 47. Illustrated description of one of the fastest, most powerful and efficient vessels ever built for fire service in America. 1000 w. Int Marine Engng—June, 1910. No. 14525 C.

Gun Turrets.

The Cutler-Hammer Manufacturing Company's Differential System of Turret Training Gear. W. H. G. Bullard. Gives a general description of this method of turret turning, explaining the principle and operation. Ills. 4500 w. Pro U S Naval Inst—15104 F.

Motor Boats.

Techincal Aspects of the 1910 Monaco Meeting (Technisches vom Monaco-Meeting 1910). Conrad Harmsen. Ills. Serial. 1st part. 2000 w. Motorwagen—May 10, 1910. No. 14888 D.

Oil Fuel.

Fuel-Oil Installation and Tests Made on U. S. S. Chayenne. F. F. Ingram. Describes the installation and reports tests. 6800 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15093 H.

First Oil-Burning Turbine Steamers. Warren O. Rogers. Illustrated description of the oil burning equipment recently installed in steamships Yale and Harvard of the Metropolitan line, New York City. 1200 w. Power—June 21, 1910. No. 15010.

Propellants.

Nitro-Cellulose Powder for Naval Purposes. Editorial discussion of the French Service explosive compound, believing it to be quite unsuitable for naval purposes, and referring to a recent article in the *Memorial des Powdres et Saltpetres.* 3000 w. Engng—May 20, 1910. No. 14470 A.

Shipbuilding.

Mitsu-Bishi Dockyard and Engine Works. An illustrated review of the history and a description of the shipbuilding and engineering works. 7000 w. Engng—May 20, 1910. No. 14472 A.

Ship Cleaning.

Removing Scale from Hulls of Ships with Pneumatic Hammers Under the Piece-Work System. Illustrates and describes tools used and methods adopted, giving results obtained. 2000 w. Marine Rev—June, 1910. No. 14970.

Corrugated Sides of S. S. "Monitoria" and Their Effect. A. H. Haver. Claims advantages in seakindliness, speed and carrying capacity. Description. Plates. General discussion. 17500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1910. No. 15144 N.

Ship Illumination.

Ship Illumination and Fittings. G. Austin. Discusses the character of illumination and fittings for various uses. Ills. 3000 w. Elect'n, Lond—June 10, 1910. No. 15026 A.

Ships' Diameter.

A New Method for Determining the Final Diameter of a Ship. D. W. Taylor. Explains a simple method of determining the final diameter in making turning trials. 700 w. Pro U S Naval Inst—June, 1910. No. 15102 F.

Ships' Telephones.

Ships' Telephones. H. S. Thompson. Illustrates and describes the general scheme adopted on board a ship, the instruments, and other details. 4000 w. Elect'n, Lond—June 10, 1910. No. 15028 A.

Steam Boilers.

A Japanese Watertube Boiler. The Miyabara watertube boiler widely used for marine and stationary work in Japan. It was installed on a number of warships that saw service in the Russo-Japanese

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war, and proved to be the only type which could be kept under steam for six months without cleaning. Ills. 1000 w. Boiler Maker—June, 1910. No. 15120.

Test of Thornycroft Boilers, Fuel-Oil Apparatus, and Fire-Room Fans on Torpedo-Boat Destroyer "Roe." C. F. Bailey. Illustrates and describes tests which indicate that the installation will prove economical. 1200 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15091 H.

Steam Engines.

The Latest Marine Engine Proposition. A. B. Willits. Gives a brief résumé of previous developments, and notes on a new and remarkable roto-turbo combination devised by Gerard P. Herrick. Ills. 5500 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15090 H.

See also Engine Testing, under MARINE AND NAVAL ENGINEERING.

Steamships.

The North Land. Illustrated description of a vessel for service between New York and Portland, Me. 1800 w. Int Marine Engng—June, 1910. No. 14521 C.

The Grand Trunk Pacific Company's T.-S.S. "Prince Rupert." Illustrated detailed description of steamers for service on the Pacific coast. Plates. 2500 w. Engng—June 17, 1910. No. 15235 A.

Bulk-Oil Steamship J. A. Chanslor. Illustrated detailed description of the vessel and its equipment. 2500 w. Int Marine Engng—June, 1910. No. 14520 C.

A New Type of Iron Ore Transport. F. C. Coleman. The "Vollrath Tham," built to the British Corporation highest class, is illustrated and described. 1500 w. Int Marine Engng—June, 1910. No. 14523 C.

Steam Turbines.

Coal Consumption of French Torpedo-Boat Destroyers with Turbines, Reciprocating Engines and Combination Machinery. Ernest N. Janson. Gives results obtained with three destroyers of the French Navy in recent official trials. Ills. 3500 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15089 H.

Impulse and Reaction Marine Steam Turbines. Sir William H. White. A criticism of previous estimates of the relative merits of German, American, and Parsons types of turbines, reviewing statements in a recently published article on "Impulse Turbines in Germany." 4000 w. Engr, Lond—May 27, 1910. No. 14622 A.

Steering Gears.

Electric Steering Gear. A. P. Chalkley. Illustrates and describes a number of systems. 3000 w. Elect'n, Lond—June 10, 1910. No. 15025 A.

Submersibles.

Submersible. Robert G. Skerrett. Explains the distinction between submarines and submersibles, considers types, factor of displacement, seaworthiness, form of hull, buoyancy, speed, etc. Ills. 11000 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15092 H.

The Norwegian Submersible Kobben. Illustrates and describes the vessel and reports trials. 800 w. Engr, Lond—June 17, 1910. No. 15242 A.

Tugs.

A Powerful Stern Wheel Towboat. Profile, cross section and description of the improved type vessel "Gamecock," designed for heavy towing. 1200 w. Int Marine Engng—June, 1910. No. 14522 C.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Acceleration.

Tractive Efforts and Acceleration of Automobile Vehicles on Land, Air, and Water. F. W. Lanchester. Read before the Inst. of Mech. Engrs. Discusses neglected aspects of the subject, explaining the method employed by the author for the measurement of acceleration and tractive effort, and showing the uses of acceleration diagrams. 1500 w. Auto Jour—May 2, 1910. Serial. 1st part. No. 14443 A.

Agricultural.

Automobiles in Agriculture (Coltivazione del Suolo mediante Veicoli automotori). S. Herzog. Describes a number of "König" automobile vehicles and machines. Ills. 3000 w. Industria—May 22, 1910. No. 14848 D.

Bodies.

When a New Body Must be Purchased. Illustrated discussion of characteristics of body types. 1800 w. Automobile—May 26, 1910. Serial. 1st part. No. 14410.

Carburation.

An Analysis of Carburation Troubles. Albert L. Clough. Discusses especially difficulties in carburation due to impurities in the fuel and difficulties arising from differences in the volatility of the fuel. 2500 w. Horseless Age—June 25, 1910. No. 15212.

Carburettors.

An Investigation of Recent Carburettors (Studie über neuere Vergaser). F. Ernstes. Describes and discusses recent types. Ills. Serial. 1st part. 3200 w. Zeitschr d Mit Motorwagen Ver—May 31, 1910. No. 14886 D.

Commercial Vehicles.

Interesting New Commercial Vehicle Models. Illustrates and describes new models. 4000 w. Com Veh—June, 1910. No. 14509 C.

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Notes on Gas-Motor Commercial Vehicle Design. T. B. Browne. Read before the Inst. of Auto. Engrs., London. Suggestions for successful designs. Ills. 2500 w. Com Veh—June, 1910. Serial. 1st part. No. 14508 C.

Daimler.

The 15-H. P. Daimler Chassis. Illustrated description. 800 w. Auto Jour—May 21, 1910. No. 14442 A.

Electric.

The Electric Vehicle Opportunity. Hayden Eames. Read before the N. E. L. A. Convention. Discusses the growing use of electric vehicles and its effect on central stations. 3300 w. Cent Sta—June, 1910. No. 14963.

Electric Batteries.

New Edison Storage Battery. Joseph B. Baker. Illustrates and describes the nickel iron battery, and its charging. 1500 w. Horseless Age—June 15, 1910. No. 14981.

Charging Ignition Batteries in Conjunction With Vehicle Batteries. Albert L. Clough. 800 w. Horseless Age—June 15, 1910. No. 14982.

How to Handle Ignition and Lighting Storage Batteries. Illustrated explanation of the general characteristics, and of the care needed. 3500 w. Horseless Age—June 1, 1910. No. 14554.

Fuel Gauges.

An Invaluable Modern Car Fitment. Drawings and description of the "Handy" fuel gauge, explaining the system. 2500 w. Auto Jour—June 11, 1910. No. 15013 A.

A Solution of the Petrol-Gauge Problem. Illustrated description of the "Handy" type of petrol gauge for use with gravity feed and pressure feed systems. 3000 w. Auto Jour—June 11, 1910. No. 15012 A.

Humber.

The 12-H. P. Humber. Illustrated description of the latest Humber chassis. 800 w. Auto Jour—May 28, 1910. No. 14607 A.

Ignition.

The Eisemann Magneto. Illustrated description of an automatic ignition device. 1200 w. Autocar—June 18, 1910. No. 15225 A.

Bosch Dual Ignition System Explained. Ills. 1000 w. Automobile—June 9, 1910. No. 14674.

Discussing Features of Various Makes of Magnetos. Herbert L. Towle. Ills. 1200 w. Automobile—June 2, 1910. Serial. 1st part. No. 14536.

Industry.

Detroit's Supremacy in Automobiles. Reviews the development of the industry in southeastern Michigan. 3500 w. Ir Trd Rev—June 2, 1910. No. 14507.

Laws.

Automobile Law Chart for States Which Regulate. Xenoption P. Huddy. Gist of the automobile laws of all the states in the Union which regulate the use of automobiles. 500 w. Automobile—June 16, 1910. No. 14966.

Lighting.

A Home-made Generator. J. B. Jolly. Illustrates and describes the generator of the "diving bell" type, designed by the writer. 1600 w. Autocar—June 4, 1910. No. 14726 A.

Maudslay.

The 17-H. P. Maudslay. Illustrates and describes the chassis of this car. 1200 w. Auto Jour—June 18, 1910. No. 15224 A.

Motor Cooling.

Recent Developments in Motor-Cooling Devices (Die Kühlung von Motorfahrzeugen unter besonderer Berücksichtigung neuerer Kühlapparate - Konstruktionen). August Bauschlicher. Illustrates and describes recent developments. Serial. 1st part. 3000 w. Zeitschr d Mit Motorwagen Ver—May 31, 1910. No. 14887 D.

Motors.

Revolving Cylinder Engines. Eric W. Walford. Discusses features of engines of the Gnome type with a view to their adoption for motor car work. Ills. 1600 w. Autocar—June 4, 1910. No. 14727 A.

Valve System and Valve Openings. Eugene P. Batzell. Theoretical investigation of the rate of opening and the duration of opening. Diagrams. 3000 w. Horseless Age—May 25, 1910. Serial. 1st part. No. 14486.

Pugeot.

The Pugeot "Twelve-Fifteen." Illustrated description of a car of the 80 M M. class. 1600 w. Auto Jour—June 18, 1910. No. 15223 A.

Spare-Rim Carrier.

An Admirable Spare-Rim Carrier. Illustrates and describes a Dunlap accessory. 1500 w. Auto Jour—June 4, 1910. No. 14725 A.

Starting.

How About Starting on the Spark? Gives opinions of autoists based on experience tending to show that it is not a dependable way of starting. 3000 w. Automobile—June 2, 1910. No. 14535.

A Foot-Starter for Petrol Cars. Illustrated detailed description of the Duff, Morgan, and Vermont foot-starter. 1500 w. Auto Jour—May 21, 1910. No. 14441 A.

The Doom of the Starting-Handle. Explains the advantages of abolishing the starting-handle in favor of the foot-starter. Ills. 1200 w. Auto Jour—May 21, 1910. No. 14440 A.

Stearns.

Fuel System of Stearns Model 30-60. Facts relating to the gasoline storage and the method of feeding it to the carbureter. Ills. 2500 w. Automobile—June 16, 1910. No. 14965.

Testing.

Automobile Testing Plant of University of Kentucky. Arthur M. Elam. Brief description of a plant for studying prob-

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lems arising in the operation of automobiles. Also describes a chart for rapidly computing the horse-power. 1200 w. Horseless Age—June 1, 1910. No. 14553.

Wheels.

Road Wheels for Light Tractors. Discusses the requirements of the Heavy Motor Car Act of 1904, in England. 2200 w. Mech Wld—June 3, 1910. Serial. 1st part. No. 14743 A.

COMBUSTION MOTORS.

Gas-Engine Rating.

Rating of Stationary Gas Engines. G. W. Lewis, and A. G. Kessler. Considers the determination of rated brake horsepower, of r. p. m., and of stroke. 800 w. Sib Jour of Engng—June, 1910. No. 14931 C.

Gas Engines.

Gas Engine Development, Construction and Application. R. A. Fraser. Reviews the development, describing the construction, some applications, etc. 4500 w. Can Engr—June 23, 1910. No. 15194.

Notes on Gas Engine Economy. P. F. Walker. Presents data derived from a series of tests made on a 6 x 12-inch engine with "hit-and-miss" governor, using natural gas and a special brake. 2000 w. Power—June 7, 1910. No. 14599.

Gas Engines for Driving Alternating Current Generators. H. G. Reist. Discusses the desirable characteristics. 1100 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14947 F.

Large Gas Engines in Steel Works. Richard Bechtel. From a paper on the Nurnberg Gas Engine, read before the Birmingham Assn. of Mech. Engrs. An illustrated article explaining their advantages in utilizing gas from blast furnaces. 4000 w. Ir Age—June 16, 1910. No. 14903.

Campbell Gas and Oil Engines at the Brussels Exhibition. Illustrated description of the exhibits of this company. 1000 w. Engng—May 27, 1910. No. 14618 A.

Gas Power Plants.

Producer Gas Plants. Short paper on the fundamental principles of such plants, introductory to a discussion of E. M Rhett's paper on this subject. 4000 w. Pro S & S-W Ry Club—May 19, 1910. No. 15254 E.

Operating Experiences with a Blast Furnace Gas Power Plant. Heinrich J. Freyn. Describes experiences and results obtained during regular service. Ills. 21500 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14943 F.

G. M. A. Gas-Power Plants Using Peat as Fuel (Die G. M. A.-Torfgasmaschinenanlagen). Describes apparatus for the utilization of peat manufactured in Gärlitz, Austria. Ills. 3000 w. Oest Zeitschr f Berg u Hüttenwesen—May 28, 1910. No. 14869 D.

Gas Producers.

See Thermodynamic Units, under STEAM ENGINEERING.

HEATING AND COOLING.

Air Liquifaction.

Industrial Oxygen (L'Oxygène industriel). Georges Claude. A review and discussion of commercial processes of production. 5000 w. Rev de Métal—May, 1910. No. 14815 E + F.

Central Plants.

The Heat Supply in Central Heating. Prof. J. D. Hoffman. From a paper read before the Nat. Dist. Heat. Assn., Toledo. Discusses the volume and effect of exhaust steam in central heating calculations. 2000 w. Met Work—June 4, 1910. No. 14519.

A Central Heating Station. W. A. Wolls. Abstract of a paper read before the Nat. Dist. Heat. Assn. Gives data of service and cost of heating. 1000 w. Power—June 28, 1910. No. 15251.

Cooling Towers.

The Influence of Atmospheric Conditions on Water-Cooling Plants (Verlauf der Kühlzonen bei Rückkühlanlagen in Abhängigkeit von den atmosphärischen Verhältnissen). Herr Willnecker. A theoretical investigation. Ills. Serial. 1st part. 4000 w. Die Turbine—May 20, 1910. No. 14878 D.

Fan Testing.

Fan Testing at the American Blower Co. Benjamin W. Loye. Briefly discusses the commercial, engineering and scientific tests. 1500 w. Minn Engr—May, 1910. No. 14767 C.

Hot-Water Heating.

Air-Venting Hot-Water Heating Systems. Charles L. Hubbard. Considers piping arrangements for the automatic escape of air, giving details of three methods. Ills. 900 w. Met Work—June 4, 1910. No. 14518.

A Short Method of Designing Hot-Water Heating Systems (Metodo abbreviato di Calcolo di Termosifoni). C. A. Gullino. Discusses the design of natural circulation hot-water heating systems. Ills. 2500 w. Monit Tech—May 10, 1910. No. 14846 D.

Refrigeration.

Ammonia. Waldemar C. Klotz. Explains its nature, origin, manufacture, and important uses. 1600 w. Ice & Refrig—June, 1910. No. 14549 C.

The Westinghouse-Leblanc Refrigerating Machine (Machine frigorifique à Eau, Système Westinghouse-Leblanc). E. Lemaire. Describes in detail the machine and the installation at the Béthune mines. Ills. 4000 w. Génie Civil—May 28, 1910. No. 14843 D.

Steam Heating.

Calculations for Heating a Concrete House. Daniel R. Bacon. Gives methods and formulae used in making the calculations for a heating system of the type described. Ills. 2200 w. Heat & Vent Mag—June, 1910. No. 14923.

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HYDRAULIC MACHINERY.

Centrifugal Pumps.

Efficiency of Centrifugal Pumps. F. W. Kerns. Gives a method of measuring the efficiency. 700 w. Min & Sci Pr—June 11, 1910. No. 14972.

A New Six-Stage Turbine Pump. Illustrated description of a pump manufactured in Glasgow. 500 w. Engr, Lond—June 17, 1910. No. 15246 A.

Recent Rateau Pump Installations (Rateaupumpen und neuere Anlagen mit Rateaupumpen). Ernst Blau. Describes the pump and applications to water-works service. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—May 6, 1910. No. 14894 D.

Electric Pumping.

Electrically Driven Pumping Plants. Illustrated description of two examples of electrically driven pumps, showing practice in Great Britain. 1500 w. Engr, Lond—June 3, 1910. No. 14758 A.

Electric Irrigation Pumping in Kansas. E. C. Reybold, Jr. Brief illustrated description of a station operating fourteen pumping plants. 1200 w. Elec Wld—June 9, 1910. No. 14658.

Brakes.

Hydraulic Brakes with Air Recuperators and Regulators (Les Freins hydrauliques avec Récupérateur à Air et Modérateur). Describes brakes of this type applied to mobile artillery. Ills. 3000 w. Tech Mod—May, 1910. No. 14828 D.

Fire Engines.

The Evolution of the Fire Engine. E. T. Rowland. Brief historical review. 2000 w. Yale Sci M—June, 1910. No. 14775 C.

Pumping Engines.

The New Triple-Expansion Pumping Engines of the Hamburg Water Works (Die Neuen Dreifach-Expansions-Pumpmaschinen des Hamburger Wasserwerkes). Rud. Schröder. Illustrated detailed description of the engines and plant. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15076 D.

Rams.

The Theory of a New, Large-Capacity Hydraulic Ram with Positive Valve Gear (Theorie eines neuen hydraulischen Widders mit Zwangläufiger Steuerung für grosse Wassermengen). Mathematical. Ills. 5000 w. Glasers Ann—May 15, 1910. No. 14892 D.

Turbine Design.

Notes on the Design of a Radial Inward-Flow Hydraulic Turbine. Claud H. Hill. Indicates the methods usually followed. Mathematical. 600 w. Can Engr —May 27, 1910. No. 14487.

Turbine Governors.

The Theory of Plate Spring Governors (La Théorie des Régulateurs à Ressorts lamellaires). R. Loewy. A mathematical discussion of their design, with special reference to their application to hydraulic turbines. Ills. 7500 w. Rev de Mécan—May, 1910. No. 15084 E + F.

Turbines.

Comparison of the Characteristic Features of Special and Stock Hydraulic Turbines. H. Birchard Taylor. The general features are compared and the fields of the two classes discussed. 4000 w. Eng News—May 26, 1910. No. 14405.

Modern American Hydraulic-Turbine Construction (Moderner amerikanischer Wasserturbinenbau). Wilhelm Müller. The first part deals with installations by James Leffel & Co., Springfield, O. Ills. Serial. 1st part. 1800 w. Zeitschr f d Gesamte Turbinenwesen — May 10, 1910. No. 14879 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Design of Ball Thrust Bearings. Henry Hess. Explains the way in which the surface forming the seat or ball race affects the efficiency and life of a ball bearing. Ills. 700 w. Am Mach—Vol. 33. No. 23. No. 14679.

Ball Levers.

Ball Levers and Drilling Jig. Illustrates and describes a typical ball lever, giving proportions used by a firm of machine tool makers. 500 w. Prac Engr—May 20, 1910. No. 14454 A.

Cams.

Developing a Cam Groove in a Cam Pattern. J. R. Moorhouse. Illustrated description of the method. 700 w. Mech Wld—May 27, 1910. No. 14614 A.

Dies.

Designing Dies Economically. Guido Sacerdote. How to design dies in order to obtain the least waste in spacing of blanks. Ills. 500 w. Am Mach—Vol. 33. No. 24. No. 14789.

Flexure.

Limitations of the Common Theory of Flexure. John S. Myers. A discussion of the design of curved machine members under eccentric load, stating conclusions. 5500 w. Mach, N Y—June, 1910. No. 14527 C.

Fly Wheels.

Explosion of a Fly-Wheel. An illustrated article describing the plant, the explosion and damage, and discussing the cause. 3000 w. Locomotive—April 25, 1910. No. 15048.

Gears.

Table of Angles and Circular Pitches for Spiral Gears. Gives a table arranged for the use of designers of spiral gears. 2000 w. Engr, Lond—June 17, 1910. No. 15239 A.

Piston Rings.

Piston Rings—Their Design and Manufacture. Stanley M. Udale. Mathematical study. 2000 w. Horseless Age—June 22, 1910. No. 15211.

Presses.

The Design of Friction Presses (Note sur le Calcul des Presses à Friction). Herr Schlessinger. Translated from

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Zeitschrift des Vereins Deutscher Ingenieure. Ills. 8000 w. All Indus—May, 1910. No. 14831 D.

Screw Threads.

The Screw-Thread Commission (Commission des Filetages). M. Sebert. A report on the standardization of screw threads presented at the congress held in connection with the Brussels exposition on behalf of the French Society for the Encouragement of National Industry. 2000 w. Bul Soc d'Encour—April, 1910. No. 14818 G.

MACHINE WORKS AND FOUNDRIES.

Brass Founding.

Making Re-Melted Spelter from Sheet Zinc Scrap, Zinc Routings, Battery Zincs. Engravers' Zinc, Etc. Illustrated article describing the treatment of the various forms of zinc found on the market in such condition that remelting and pouring will give good spelter. 2000 w. Brass Wld—June, 1910. No. 14720.

Burnishing.

Lathe Burnishing of Metals. William A. Painter. General remarks with illustrated description of a method of burnishing much used. 2000 w. Mach, N Y—June, 1910. No. 14528 C.

Chain Making.

The Manufacture of Driving Chains. Illustrated description of works and methods of Messrs. Hans Renold, Manchester, Eng. 2000 w. Elec Rev, Lond—May 20, 1910. No. 14446 A.

Core Ovens.

Drying-Oven Doors (Die Trockenkammer-Verschlusstüren in ihrer Anwendung). H. Vetter. Describes a number of types. Ills. Serial. 1st part. 1500 w. Giesserei-Zeit—May 1, 1910. No. 14863 D.

Cupola Practice.

Chemistry and Cupola Practice. W. W. Cox. Read before the Kansas City branch of the Am. Chem. Soc. Considers the combined carbon content of machinery castings. 1200 w. Ir Age—June 16, 1910. No. 14901.

Chemistry and Cupola Practice. W. W. Cox. Discusses the causes of variations in physical and chemical properties of grey iron. 1500 w. Foundry—June, 1910. No 14593.

Dies.

Dies for Offsetting Steel Angles. S. Hurley. Illustrates and describes a die that requires but one operation of a hydraulic press to shape two pieces and also produce angles shaped right and left. 1200 w. Am Mach—Vol. 33. No. 25. No. 15127.

Out-of-Date Die-Making Methods. F. E. Shailor. An illustrated comparison of old and modern methods. 1500 w. Mach, N Y—June, 1910. No. 14530 C.

Enamelling.

Enamelled Cast-Iron Sanitary Ware. Dillen Underhill. Describes the cooling ovens and arrangement of the enamelling room, and method of crating tubs and lavatories. 3000 w. Foundry—June, 1910. No. 14596.

Extrusion Presses.

The Extrusion of Metals in the Solid State. Discusses its limitations and most useful applications, illustrating presses for different kinds of work. 2000 w. Ir Age—June 23, 1910. No. 15116.

Foundries.

Model Foundry for Casting Iron. E. F. Lake. Illustrated description of a foundry in Providence, R. I., which uses machinery wherever possible to effect a saving in labor. 1500 w. Am Mach—Vol. 33. No. 23. Serial. 1st part. No. 14676.

Foundry Coke.

Specifications for Foundry Coke. Dr. Richard Moldenke. Read before the Am. Found. Assn. Suggested specifications, with general remarks. 1400 w. Ir Age—June 16, 1910. No. 14902.

Foundry Design.

Economizing Space in the Foundry. Walter J. May. Suggestions for making the most of restricted floor space. 900 w. Prac Engr—June 3, 1910. No. 14740 A.

Foundry Flasks.

Shaped Flasks for Special Castings. Walter J. May. Brief remarks on when the cost of shaped flasks is warranted, giving examples. Ills. 700 w. Prac Engr—May 20, 1910. No. 14456 A.

Foundry Furnaces.

The "Anthony" Oil Melting Furnace. Illustrates and describes this type of metal melting furnace. 600 w. Brass Wld—June, 1910. No. 14723.

Foundry Practice.

Foundry Efficiency. Benjamin D. Fuller. Reports some methods which have been proven successful. 1000 w. Am Found Assn—June, 1910. No. 15107 N.

Galvanizing.

Some Chemical Engineering Problems. C. F. Burgess. Explains a few problems illustrating the nature of the work in chemical engineering, relating principally to galvanizing processes. 2000 w. Wis Engr—June, 1910. No. 14929 D.

Gear Cutting.

Why Gear Hobbing Machines Cut Flats. George B. Grant. A demonstration of the difficulties encountered in the use of the hob for generating spur and spiral gear teeth. Ills. 1200 w. Am Mach—Vol. 33. No. 25. No. 15126.

Grinding.

Economy in Grinding. J. J. Thacher. Suggestions for use of the Brown and Sharp grinders. Ills. 1500 w. Prac Engr—May 27, 1910. No. 14610 A.

Examples in Modern Grinding Practice. H. Darbyshire. Practical suggestions. 2500 w. Am Mach—June 16, 1910. No. 14794.

Grinding Machines.

Natural and Artificial Grinding Wheels

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(Meules en Grès et Meules artificielles). G. Dumont. A discussion of safety devices applied to grinding wheels. Ills. 4000 w. Tech Mod—May, 1910. No. 14829 D.

Lathes.

A Comparison of Lathe Headstock Characteristics. Prof. Walter Rautenstrauch. Discusses a comparison made on the basis of those characteristics of speed and torque in a lathe headstock which permit the most economic removal of shavings from a given class of material. 3000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14944 F.

Back Gearing for Lathes. The principles of designing lathe cone steps, and double back gear ratios to give suitable speed changes without duplication. 1500 w. Am Mach—Vol. 33. No. 25. No. 15125.

Cone Drive versus Gear Drive. A discussion by William Lodge and R. K. LeBlond favoring the cone pulley. 3500 w. Ir Age—June 2, 1910. No. 14526.

Erecting and Testing a Lathe. T. Metcalfe. (Prize paper.) Drawings and detailed description. 1800 w. Mech Wld—June 3, 1910. Serial. 1st part. No. 14742 A.

A Large Lodge & Shipley Crankshaft Lathe. Illustrates and describes details of the crankshaft turning attachment. 1000 w. Ir Age—June 23, 1910. No. 15119.

Machine Tools.

The Automobile and Machine Tools. Robert Pierpont. Read before the Nat. Machine Tool Bldrs. Assn. Discusses the future of this new industry and its relation to machine design. 3500 w. Ir Age—June 2, 1910. No. 14482.

Machine Tools at the International Motor Boat and Motor Exhibition (Werkzeugmaschinen auf der Internationalen Motorboot- und Motoren-Ausstellung 1910). A. H. Simon. Describes the exhibits. Ills. Serial. 1st part. 1500 w. Motorwagen—May 10, 1910. No. 14889 D.

Milling Machines.

The No. 4 Hendey Universal Milling Machine. Illustrates and describes interesting details of a new dividing head and other mechanisms. 800 w. Ir Age—June 2, 1910. No. 14485.

Molds.

Iron Molds for Making Castings. Illustrated description of methods developed by Edgar A. Custer, Tacony Ironworks, Philadelphia. 2000 w. Engr, Lond—June 17, 1910. Serial. 1st part. No. 15238 A.

Molding.

Molding Bulldozer Frame. Jabez Nall. Illustrated description of method used. 2500 w. Am Mach—Vol. 33. No. 25, No. 15128.

Molding Circular Segment Plates. G. Buchanan. Illustrates and describes details of the construction of the pattern and the making of the castings. 1000 w. Foundry—June, 1910. No. 14594.

Molding Machines.

A Few Problems in Machine Molding. Illustrates and describes shop work where 169 molding machines of seven different types are operated. 3500 w. Foundry—June, 1910. No. 14592.

Recent Special Molding Machines of the United Emery and Machine Co., Hannover-Hainholz (Neuere Sonderformmaschinen der Vereinigten Schmirgel- und Maschinen-Fabriken A.-G., Hannover-Hainholz). R. Lüssenhop. Describes machines for moulding smoothing irons, pots, etc. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15077 D.

Pattern Making.

Pattern Cock and Valve Work. Joseph Horner. Illustrated discussion of some of the difficulties and problems. 2500 w. Mech Wld—June 10, 1910. Serial. 1st part. No. 15036 A.

Patternmaking for Bulldozers. Jabez Nall. Illustrates and describes the procedure in making patterns for Ajax high speed bulldozer. 1700 w. Am Mach—Vol. 33. No. 22. Serial. 1st part. No. 14499.

Pneumatic Tools.

The Maintenance, Care and Up-Keep of Pneumatic Hammers. George H. Hayes. Remarks on the abuses which these tools receive. 1500 w. Mach, N Y—June, 1910. No. 14532 C.

A New Compressed Air Hammer. Illustrated description of a machine in which air under pressure is supplied from an independent plant. 1200 w. Engr, Lond—May 20, 1910. No. 14478 A.

Safety Devices.

Shall Manufacturers be Obliged by Law to Protect Gearing (Soll den Maschinenfabrikanten die Verkleidung der Zahn- und Kettenräder gesetzlich vorgeschrieben werden)? Georg Urban. Discusses the accidents caused by exposed gears and the arguments for forcing manufacturers to protect them. 2000 w. Tech u Wirt—May, 1910. No. 15080 D.

See also Grinding Machines, under MACHINE WORKS AND FOUNDRIES.

Screw Cutting.

Threading Operations. Douglas T. Hamilton. Illustrates and describes practice for the Brown & Sharpe automatic screw machine. 4500 w. March, N Y—June, 1910. Serial. 1st part. No. 14529 C.

Shears.

Universal Shears for Channels, Angles, and Plates. Brief description, with illustrations. 300 w. Engng—May 27, 1910. No. 14620 A.

Shop Design.

Metal-Working Plants and Their Machine-Tool Equipment. Charles Day. This second of two articles deals with the characteristics of plants for machinery building and repairs. 5000 w. Engineering Magazine—July, 1910. No. 15261 B.

We supply copies of these articles. See page 807.

Shop Floors.

Wearing Surface for Factory Floors. Information from a recent report giving a summary of replies to inquiries about granolithic or other masonry floors, and wood-top floors. 3000 w. Eng Rec—May 28, 1910. No. 14415.

Shop Practice.

Some Causes of Faulty Work. Considers points from a general viewpoint, applicable to works of various classes. Discusses drawings, methods of indicating dimensions, and fixing allowances, in the present number. 1500 w. Prac Engr—June 3, 1910. Serial. 1st part. No. 14741 A.

Machine Efficiency. Oscar E. Perrigo. Suggests methods of improving the ratio between expense and output in machine tool equipment. 4000 w. Ir Trd Rev—Jnue 23, 1910. No. 15146.

Shop Kinks. Illustrates and describes practice at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul. 1200 w. Ry Age Gaz—June 3, 1910. No. 14543.

The Manufacture of Frogs and Switches. J. B. Haskell. Illustrated description, based especially on the practice of the American Frog and Switch Co. of Hamilton, Ohio. 1800 w. Mach, N Y—June, 1910. No. 14531 C.

Making Walschaerts Valve Gear Parts. Ralph E. Flanders. Explains the advantages of this gear and gives illustrated description of the various operations in its manufacture. 3500 w. Mach, N Y—June, 1910. No. 14533 C.

Finishing Stay-Bolts and Straight and Taper Bolts for Locomotives. C. K. Lassiter. Illustrates and describes the methods and devices used. 2000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14945 F.

New Cincinnati Planer Shops. Illustrated description, with explanation of methods used in building planers. 1800 w. Am Mach—Vol. 33. No. 23. No. 14680.

Heavy English Equipment Tools. I. W. Chubb. Methods of building heavy equipment are illustrated and described. 3000 w. Am Mach—Vol. 33. No. 25. No. 15124.

Building the Maxwell Automobile. Interesting operations and special fixtures are illustrated and described. 1600 w. Am Mach—Vol. 33. No. 22. No. 14497.

Making Gun Stocks and Receivers. Frank A. Stanley. Illustrates and describes methods of turning and finishing gun stocks and machining receivers. 2000 w. Am Mach—June 9, 1910. No. 14678.

Manufacturing Shot Gun Barrels. Frank A. Stanley. Illustrates and describes the more important and interesting processes. 3500 w. Am Mach—Vol. 33. No. 22. No. 14496.

Revolver and Rifle Barrel Work. Frank A. Stanley. Illustrates and describes machines, attachments, and methods for accomplishing accurate results. 2000 w. Am Mach—Vol. 33. No. 24. No. 14788.

Milling and Accurate Machine Slide. A. J. Baker. Gives illustrated details of the fixtures, cutters, and gauges employed, and a record of speeds and feeds used. 1600 w. Am Mach—Vol. 33. No. 22. No. 14498.

Machining Aluminum Crank Cases. Illustrates and describes fixtures and tools used to secure large outputs by rapid methods. 1200 w. Am Mach—Vol. 33. No. 24. No. 14793.

Rigging Up to Make a Spiral Sleeve. Describes how the various operations were accomplished with special fixtures rigged up on the planer. Ills. 2000 w. Am Mach—Vol. 33. No. 24. No. 14792.

Shops.

See Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Welding.

Electrical Welding. Briefly describ s the arc process, and the resistance process. 1200 w. Prac Engr—May 20, 1910. No. 14455 A.

Incandescent Welding. C. B. Aull. Briefly describes the LaGrange-Hoho and the Thompson processes and illustrates and describes typical examples of welding machines. 3500 w. Elec Jour—June, 1910. No. 14770.

Electric Spot Welding. A. E. Buchenberg. Describes methods, machines and applications of the spot-welding process. 1600 w. Elec Wld—June 2, 1910. No. 14503.

The Oxy-Acetylene Welding Process. J. F. Springer. Illustrated article considering its chemical reactions and typical applications to foundry repairs. 3000 w. Ir Age—June 16, 1910. No. 14904.

Autogenous Welding in a Railway Shop. H. W. Jacobs. Illustrates and describes the plant and methods of the A. T. & S. F. 2200 w. Ry Age Gaz—June 17, 1910. No. 14975.

Investigations of Autogenous Welding of Plates and Boiler Parts (Versuche mit autogen geschweissten Blechen und Kesselteilen). C. Bach. A brief review of the results of tests by the International Association of Boiler Inspection Companies. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—May 21, 1910. No. 15075 D.

See also same title, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Woodworking Machines.

The Speed of Woodworking Machine Tools. James F. Hobart. A discussion of power economy, and of the merits of the group plan or separate motor for machine drives. 2500 w. Wood Craft—June, 1910. No. 14548.

Woodworking Machines at the Brussels Exhibition. Illustrates and describes a horizontal log band-mill, and a woodplaning and matching machine, and briefly considers other machines shown. 1500 w. Engng—May 20, 1910. No. 14466 A.

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MATERIALS OF CONSTRUCTION.

Alloys.

See Thermo-Electric Properties, under ELECTRICAL ENGINEERING, ELECTRO-PHYSICS.

Alloy Steels.

Vanadium Steel. William E. Gibbs. Considers its properties and advantages. 4000 w. Cassier's Mag—June, 1910. No. 14642 B.

Cast Iron.

Chemical Standards for Iron Castings. Extract from the report of the Committee on Standards for Iron Castings, giving a large collection of analyses. 3000 w. Am Found Assn—June, 1910. No. 15106 N.

Metallography.

A Magnetic Holder for the Microscopical Examination of Metals. Albert Sauveur. Illustrated description of the device. 600 w. Ir Age—June 23, 1910. No. 15117.

The Microscope and Some of Its Applications to Metallurgy. Wirt Tassin. Read before the Phila. Found. Assn. An illustrated microscopic study of metal structure. 2500 w. Ir Age—June 9, 1910. No. 14652.

Microscopic Metallography and its Industrial Applications (La Métallographie microscopique et ses Applications industrielles). Léon Guillet. A report of a practical address on this subject. Ills. 3000 w. Tech Mod—May, 1910. No. 14824 D.

Segregation of Metalloids in Steel. S. S. Knight. Observations on this phenomenon, giving results of research work in the field of the silicon-iron compounds. Ills. 1200 w. Foundry—June, 1910. No. 14595.

Steel.

The Hardness of Steel. George Auchy. Explains static and dynamic hardness, discussing the Brinell, and Shore tests, and points to be kept in mind in making them. 2200 w. Ir Age—June 9, 1910. No. 14654.

Tin.

The Contagious Diseases of Metals. An illustrated account of the researches of Prof. Ernest Cohen. 2500 w. Sci Am—June 25, 1910. No. 15142.

The Diseases of Metals (De Forceerziekte der Metalen). Ernst Cohen. A discussion of the corrosion of tin. Ills. 7000 w. De Ingenieur—May 7, 1910. No. 15081 D.

Type Metal.

Type, Electrotype, Linotype, Stereotype and Monotype Metals. Alfred McCue. Considers metals for casting type. 900 w. Brass Wld—June, 1910. No. 14722.

MEASUREMENT.

File Testing.

German File Testing Machine. Dr. Alfred Gradenwitz. Illustrates and describes a machine for testing the quality of files. 1500 w. Am Mach—Vol. 33. No. 23. No. 14677.

Flywheel Testing.

Topical Discussion on Recent Developments in Wheel Testing. Dr. C. H. Benjamin. Reviews the progress in this kind of experimentation since the first work reported in 1898. Illustrates and describes the testing pit recently established at Purdue University. 2000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14950 F.

Gauging.

Gauging Cylindrical Bores. Explains method and necessary calculations. 1000 w. Mech Wld—May 20, 1910. No. 14461 A.

Deformations.

New Apparatus for Measuring Deformations in Materials. H. C. Berry. Illustrates and describes an apparatus made in the shop of the University of Pennsylvania for accurate measurement of deformations of webs of beams, etc. 900 w. Eng Rec—June 11, 1910. No. 14604.

Manometers.

The Accuracy of High-Pressure Measuring Instruments (Der Genauigkeitsgrad von Hochdruckmessern). G. Klein. Describes and reports tests on manometers of various types. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—May 14, 1910. No. 15074 D.

Pipe Testing.

The Testing of Pipes and Cylindrical Shells by Means of Compressed Gas (Su alcune Modalita di Prova dei Tubi e delle Bombe per gas Compressi). F. Giordano. Describes a new apparatus for the measurement of deformations. Ills. 3500 w. Monit Tech—May 10, 1910. No. 14845 D.

Press Testing.

The Cylinder Compression Test for Presses (Das Prüfen von Pressen mit Hülfe von Stauchzylindern). H. Gäntzlen. Describes and gives results obtained with a method of testing presses developed at Lewis Institute, Chicago. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15078 D.

Pyrometry.

Electric Heating and Pyrometry. Abstract of the concluding lecture of Prof. J. A. Fleming on the methods of measuring temperature. Ills. 300 w. Engng—June 17, 1910. No. 15236 A.

Recording Instruments.

Automatic Recording Instruments. Illustrated descriptions of modern registering or recording instruments which particularly appeal to the engineering industries. 2500 w. Mech Engr—June 17, 1910. Serial. 1st part. No. 15233 A.

Screw Testing.

A Machine for Testing the Efficiency of Screws (Machine à Mesurer le Rendement des Vis). Ch. Frémont. Describes a machine for measuring the efficiency of screws used for lifting weights. With a historical note on the origin of screws and gears. Ills. 6000 w. Rev de Mécan—May, 1910. No. 15085 E + F.

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Testing Methods.

The Inspection and Testing of Engineering Materials and Machinery. C. W. V. Biggs. Deals with the requirements which can reasonably be expected from various types of machinery, and the best way to ascertain that these requirements are fulfilled. 6500 w. Soc of Engrs—June 6, 1910. No. 14916 N.

Comparison of the Tensile, Impact-Tensile, and Repeated-Bending Methods of Testing Steel. Bertram Blount, W. G. Kirkaldy, and H. Riall Sankey. Report of tests. Ills. 7500 w. Inst of Mech Engrs—May 27, 1910. No. 14747 N.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors. Discusses points of construction. 1200 w. Prac Engr—May 27, 1910. No. 14611 A.

Air Compressor Cylinder Ratios. Snowden B. Redfield. Discusses theoretical and practical conditions which give maximum economy in compounding air compressor cylinders. Ills. 3000 w. Power—June 14, 1910. No. 14715.

Air Compression in an Exhaust-Steam Piston Compressor at the Fürstenstein Mines, Waldenburg (Die Presslufterzeugung auf den Fürstensteiner Gruben in Waldenburg durch einen Abdampfkolbenkompressor). Carl Wolff. Describes the plant and gives results. Ills. Serial. 1st part. 5000 w. Glückauf—May 21, 1910. No. 14873 D.

Compressed Air.

Energy of Compressed Air. Snowden B. Redfield. An analysis of the power and heat transformation taking place in an air compressor cylinder. 2500 w. Am Mach—Vol. 33. No. 24. No. 14790.

The Economy of Compressed Air at Various Pressures and Temperatures (Die Wirtschaftlichkeit des Druckluftbetriebes mit verschiedenen Spannungen und Temperaturen). H. Reiser. A practical discussion, based on experimental data. Ills. 5000 w. Glückauf—May 14, 1910. No. 14872 D.

Cost.

Power Investigation in a Grain Mill. Gives details of the analysis of the cost of power service at a large mill in Providence, R. I. 1000 w. Eng Rec—June 11, 1910. No. 14693.

Critical Speeds.

Critical Speed Calculation. S. H. Weaver. Gives a mathematical treatment for both the distributed and the concentrated loads, by considering the motion of the shaft as vibratory along two axes; reduces formulae and gives tables for practical use. 4500 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14948 F.

Electric Driving.

Magnet Switch Control for Driving-Wheel and Car-Wheel Lathes. J. H. Klinck. An illustrated article explaining the advantages of magnet switch control for wheel work. 1500 w. Elec Jour—June, 1910. No. 14773.

The Motor Drive. Richard D. Gatewood. Discusses its use in shops and on ships. Ills. 6000 w. Pro U S Naval Inst—June, 1910. No. 15103 F.

Interaction of Flywheels and Motors When Driving Roll Trains by Induction Motors. F. G. Gasche. An analysis aiming to exhibit the manner of disposition of certain important elements. 3000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14957 F.

Electricity in the Printing Office. Frank Broadbent. Presents the advantages in economy, convenience, increase in output, and quality of work. 2200 w. Elec Rev, Lond—June 3, 1910. No. 14728 A.

Electric Driving of Cotton-Picking Machinery. Albert Walton. An illustrated comparison of direct and group driving. 5000 w. Cassier's Mag—June, 1910. No. 14637 B.

The Electrical Equipment of Messrs. Edward Lloyd, Ltd. Illustrated description of the equipment of this large printing plant. 2500 w. Elec Rev, Lond—June 3, 1910. No. 14729 A.

Lubrication.

Forced Lubrication. R. K. Morcom. Read before the Inst. of Mech. Engrs., London. States some established conclusions, giving particulars of lubrication systems. 1800 w. Automobile—June 9, 1910. Serial. 1st part. No. 14675.

Mechanical Plants.

Mechanical Plant of the Provident Bank Building, Cincinnati. Walter C. Franz. Plans and description of a plant for a 10-story building. 1600 w. Eng Rec—May 28, 1910. No. 14420.

Power Plants.

Some Points Relating to Railway Shop Power Plants. E. M. Rhett. Considers the design and operation of such plants, the functions, and points of interest. General discussion. 1200 w. Pro S & S-W Ry Club—March, 1910. No. 15049 E.

Tidal Power.

Tidal Movements as Motive Power (Utilisation du Flux et du Reflux de la Mer comme Force motrice). J. Séverin. A discussion of the progress made in harnessing tidal power and the possibilities. Ills. 3500 w. L'Elecn—May 28, 1910. No. 14823 D.

STEAM ENGINEERING.

Boiler Draft.

The Prat System of Forced Draft (L'Aspirazione meccanica dei Gas combusti negli Impianti di Caldaie a Vapore secondo il sistema Prat). Illustrated description. 1500 w. Industria—May 8, 1910. No. 14847 D.

Boiler Capacity.

See Thermodynamic Units, under STEAM ENGINEERING.

Boiler Management.

A Boiler-Testing Installation and the Economical Combustion of Fuel. Charles Edward Larard. Discusses the maintaining of uniform high boiler efficiency at a minimum of cost. 3500 w. Engng—June 3, 1910. Serial. 1st part. No. 14748 A.

Mechanical and Physical Control of Combustion in Boiler Furnaces (Le Controle mécanique et physique de la Combustion dans les Foyers industriels). Eugène Grandmougin. Describes feed-water meters, differential manometers, and other devices. Ills. 4000 w. Génie Civil—May 7, 1910. No. 14835 D.

Boiler Waters.

The Selection of a Boiler Feed Water. J. C. William Greth. Considers the impurities common to water supplies, and the importance of soft, clear non-corrosive water. General discussion. 11000 w. Pro Engrs Soc of W Penn—May, 1910. No. 15047 D.

Condensers.

The Quantity of Circulating Water Required in Surface Condensers. R. M. Neilson. Discusses the determining of the quantity of water to be used to meet the conditions. 4000 w. Engr, Lond—June 17, 1910. No. 15240 A.

Friction Loss in Surface Condensers. W. Vincent Treeby. Presents curves giving the frictional head of 1, 2, 3, and 4 pass condensers. 400 w. Power—June 14, 1910. No. 14714.

Some New Condensers (Quelques Condenseurs nouveaux). A review of recent condenser literature and patents. Ills. 8500 w. Rev de Mécan—May, 1910. No. 15086 E + F.

See also Turbine Plants, under STEAM ENGINEERING.

Condenser Water.

See Intakes, under CIVIL ENGINEERING, WATER SUPPLY.

Economizers.

Power Plant Economizers. Frank Kingsley. Argument as to the merits of economizers, giving an anaylsis of their efficiency and discussing related matters. 3500 w. Eng Rec—June 4, 1910. No. 14569.

Engine Compression.

Is Compression Economical? Gives results, and conclusions drawn from tests, which proved that the more compression the less power per pound of steam. 10500 w. Power—June 28, 1910. No. 15252.

Engine Cranks.

The Proper Fitting of Engine Cranks. H. S. Brown. Simple and explicit directions. Ills. 1000 w. Power—June 14, 1910. No. 14716.

Engine Erection.

Erecting a 750 I. H. P. Horizontal Tandem Compound Condensing Corliss Engine. H. Graham. Drawings with detailed description. 1500 w. Prac Engr—June 17, 1910. No. 15230 A.

Engine Governors.

Charles Beer's Theory of Engine Governors (Théorie de M. Charles Beer sur les Régulateurs de Vitesse). V. Dwelshauvers-Dery. A mathematical exposition and criticism of this theory. Ills. 9000 w. All Indus—May, 1910. No. 14830 D.

Engines.

The Revival of the Reciprocating Engine. R. J. S. Pizott. This first article of a series deals with thermal characteristics and problems of design of combination steam plants. Ills. 3000 w. Engineering Magazine—July, 1910. No. 15263 B.

See also Rotary Engines, under STEAM ENGINEERING.

Engine Testing.

Apparatus for Measuring Feed Water on Marine-Engine Trials. Illustrated description of the tank arrangements which the Stettiner Maschinenbau-Aktien-Gesellschaft Vulcan uses. 500 w. Engng—May 27, 1910. No. 14619 A.

Feed-Water Heating.

Feed Water Heating in a Cotton Mill. Harvey B. Mann. Gives an analysis of cost and returns for various systems. 1200 w. Sib Jour of Engng—June, 1910. No. 14933 C.

Fuel Purchasing.

The Purchase of Coal on an Efficiency Basis. A. O. Doane. Points out some considerations governing a purchaser of fuel, showing the effect of impurities and constituents, considers tests, specifications and the subject generally. Discussion. 7500 w. Jour N Eng W-Wks Assn—June, 1910. No. 14936 F.

Analyses and Buying of Steam Coal. From the report of the committee on fuel supply, Boston Chamber of Commerce. 4000 w. Ry Age Gaz—June 24, 1910. No. 15156.

Fuel Testing.

Federal Investigations of Mine Accidents, Structural Materials, and Fuels, at the United States Testing Station, Pittsburg, Pa. Discussion of Herbert M. Wilson's paper. 5000 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14942 E.

Indicators.

Continuous Records from Indicator. N. L. Daney. An illustrated description of an electrically-controlled system, which gives simultaneous diagrams from both ends of all cylinders, and automatically records such information as is required for power calculations. 2200 w. Power—May 31, 1910. No. 14428.

Mechanical Stokers.

Early History of Stokers in England. J. F. Springer. Illustrated review of early automatic stokers. 3500 w. Power—June 7, 1910. No. 14598.

Side Feed Automatic Stokers. J. F. Springer. An illustrated résume of this type of stoker, giving typical installations

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of present day practive. 2500 w. Power —June 14, 1910. No. 14713.

Mechanical Stoking of Steam Boilers (Conduite mécanique de la Chauffe dans les Foyers des Générateurs de Vapeur). M. Emanaud. An exhaustive discussion of the theory of stoking and the advantages of mechanical stokers. Serial. 1st part. 3500 w. Génie Civil—May 28, 1910. No. 14844 D.

Rotary Engines.

The Herrick Rotary Engine. Illustrated description of an engine with a steam balanced rotor. 2500 w. Ir Age—June 2, 1910. No. 14483.

Herrick Balanced Rotary Engine. Illustrates and describes the mechanical details of a new type of rotary engine. 1000 w. Power—May 31, 1910. No. 14430.

Steam Piping.

Steam Piping at Collieries and Ironworks. Discusses important considerations which arise in this connection. 2200 w. Col Guard—June 10, 1910. No. 15037 A.

Piping for the Steam Plant. Percival R. Moses. From an article in *The Isolated Plant*. Information and suggestions for a safe system of piping. 2500 w. Am Gas Lgt Jour—June 6, 1910. No. 14550.

Thermal Storage.

Thermal Storage. Illustrates and describes the Druitt-Halpin system as installed by St. Pancras Dept. for the King's-road works. 1400 w. Engr, Lond —June 3, 1910. No. 14759 A.

Thermodynamic Units.

Two Proposed Units of Power. Prof. William T. Magruder. Suggestions for new unit to measure the capacity of a boiler; and a new unit for the capacity of a gas producer, coke oven, or blast furnace to deliver available heat energy. 3000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14946 F.

Turbine Design.

A Heat Diagram for Use in Turbine Design. John Morrow. Gives diagram explaining its construction and use. Plates. 2000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1910. No. 15145 N.

Turbine Economy.

The Effect of Vacuum on the Economy of Steam Turbines. R. M. Neilson. Explains why the efficiency of a turbine is affected by change in the terminal pressure. 1800 w. Elect'n, Lond—June 17 1910. No. 15229 A.

Turbine Plants.

Extensions to Electricity Supply Stations by Means of Mixed Pressure Turbines. Ashton Bremner. Describes an installation at Burslem and gives particulars of the saving obtained. 500 w. Elect'n, Lond—June 17, 1910. No. 15227 A.

Exhaust Steam Turbines and Condensing Plant at McDonald Road Station. F. A. Newington. Describes turbines recently installed in Edinburgh. Sewage is used for condensing purposes. 2500 w. Elect'n, Lond—June 17, 1910. No. 15226 A.

Turbines.

300-Horse-Power Impulse Steam-Turbine. Illustrations and description of the principal features of the machine of the multicellular impulse type. 1000 w. Engng—June 3, 1910. No. 14750 A.

Barbezat Steam Turbine. P. Andre. Illustrated description of a new turbine which is essentially a combination of the DeLaval and Parsons types. 1000 w. Mech Engr—May 27, 1910. No. 14613 A.

The A. E. G. Steam-Turbine. Illustrated description of a 2000-kilowatt velocity-compounded steam-turbine having but two pressure stages, and two wheels per stage. 2500 w. Engng—May 20, 1910. No. 14465 A.

The Elektra Steam Turbine. Dr. H. Meuth. Illustrates and describes its construction and operation, and considers fields of use. 4000 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15088 H.

The Oerlikon Series-Parallel Turbine for Either Exhaust or Live Steam (Turbine "série-parallèle" Oerlikon fonctionnant avec de la Vapeur d'Echappement et de la Vapeur fraiche). Describes the turbine and gives results of tests. Ills. 2000 w. Génie Civil—May 7, 1910. No. 14837 D.

Recent Examples of Steam-Turbine Construction (Neuere Konstruktionen von Dampfturbinen). K. Körner and F. Lösel. The first part discusses the development of the small steam turbine in America. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—May 7, 1910. No. 15071 D.

Turbine Testing.

Testing Steam Turbines With a Water Brake. Winslow H. Herschel. Discusses the proper method of taking readings of speed and torque in such tests. 1200 w. Harvard Engng Jour—May, 1910. No. 14779 D.

Valves.

Two New Valves. Illustrated description of a new steam controlling valve, and a combined check and steam valve. 1200 w. Engr, Lond—June 17, 1910. No. 15247 A.

Watt Museum.

Museum of Watt Developments. I. W. Chubb. Illustrated account of the famous drawings, letters and other relics contained in the Tangye Museum, Birmingham, Eng. 4500 w. Power—June 21, 1910. No. 15011.

TRANSPORTING AND CONVEYING.

Coal Handling.

Coal Handling Plant of the Radzionkau Mine in Upper Silesia (Die Verladeanlage der Radzionkaugrube in Oberschlesien). M. Buhle. Describes an elaborate car haulage, dumping and storage plant, built by Ernst Heckel. Ills. 5500

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w. Zeitschr d Ver Deutscher Ing—May 7, 1910. No. 15072 D.

Conveyers.

Notes on Conveyors. Remarks on the many applications, types suited to various conditions, etc. 4000 w. Mech Wld—May 27, 1910. No. 14615 A.

Cranes.

Electrically-Driven Shipyard Cranes. H. H. Broughton. Considers details that the performance of all types of electric cranes, and illustrates and describes several systems. 6500 w. Elect'n, Lond—June 10, 1910. No. 15022 A.

Freight Handling.

See Terminals, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

MISCELLANY.

Aerodynamics.

An Aerodynamic Laboratory (Installation d'un Laboratoire d'Aérodynamique). G. Eiffel. Brief description of the author's new laboratory in Paris and some of the results obtained. Ills. 4500 w. Tech Mod—May, 1910. No. 14827 D.

Aeronautics.

Automatic Stability in Aeroplanes. Adapted from the German of R. Conrad by Marius G. Krarup. Extract of the reasoning on the subject of the available mechanical expedients for avoiding loss of balance. Ills. 1000 w. Automobile—June 2, 1910. Serial. 1st part. No. 14534.

Ferber's Theory of Aeroplane Stability. A detailed account of Captain Ferber's analysis. Mathematical. 3500 w. Engng—May 20, 1910. No. 14473 A.

Studies in Aviation Theory and Practice. Marius G. Krarup. Briefly considers sustentation, equilibrium, propulsion and materials. 2000 w. Automobile—May 26, 1910. Serial. 1st part. No. 14411.

Aviation in Theory and Practice (Der heutige Stand der Flugtechnik in Theorie und Praxis). F. Bendemann. A discussion of the present status of aeronautics. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—May 14, 1910. No. 15073 D.

Aeroplane versus Dirigible. Editorial discussion of the use of the two machines in warfare. 1700 w. Engng—June 3, 1910. No. 14751 A.

How Airships Are Likely to Affect War. B. Baden-Powell. Discusses briefly the capabilities and difficulties of airships, the uses to which they may be applied, and matters related. General discussion follows. 14500 w. Jour Roy U S Inst—May, 1910. No. 14649 N.

The Albany-New York Aeroplane Flight. An illustrated account of the flight of Glenn H. Curtiss on May 29, 1910. 2000 w. Sci Am—June 11, 1910. No. 14668.

Clocks.

Mechanical Clocks (L'Horlogerie mécanique). Léopold Reverchon. A review of the invention and development of clocks, modern progress, the clock industry, etc. Ills. 10000 w. Rev Gen d Sci—May 30, 1910. No. 14821 D.

Textile Machinery.

Textile Machinery at the Brussels Exhibition. Illustrates and describes the exhibits of cotton machinery, showing modern development. Plates. 4000 w. Engng—June 3, 1910. No. 14749 A.

See also Electric Driving, under POWER AND TRANSMISSION.

Vacuum Cleaners.

Carey's Vacuum Cleaning and Disinfecting Apparatus. Illustrated description of a rather novel type of portable vacuum cleaning apparatus. 1000 w. Engng—May 20, 1910. No. 14468 A.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Accidents in the Coal Mines of the U. S., 1909. Edward W. Parker. Reviews the statistics of accidents in different states since 1884, discussing causes. 4500 w. Min Wld—June 25, 1910. No. 15217.

Alberta.

The Galt Coal Field, Alberta. W. D. L. Hardie. Brief description. 1200 w. Qr Bul Can Min Inst—April, 1910. No. 15187 N.

The International Coal & Coke Co.'s Colliery at Coleman, Alta. G. L. Burland. Illustrated description. 6500 w. Jour Can Min Inst—1909. No. 15178 N.

Australia.

The West-Moreton Coal Mines. J. A. Thomas. An illustrated account of the expansion of the industry and the advantages of coal-cutting machines. 1500 w. Queens Gov Min Jour—April 15, 1910. No. 14604 B.

Blasting.

Firing Black Powder by Electricity. Illustrates and describes apparatus for firing either black powder or permitted explosives with safety and economy. 2500 w. Mines & Min—June, 1910. No. 14564 C.

A Commercial Fuel-Briquette Plant. Discussion of paper by W. H. Blauvelt. 4000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15099 F.

Coking.

The Production and Use of Coke. W. Hartman. Considers the suitable coals,

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qualities of the different cokes, etc. 1500 w. Eng & Min Jour—June 4, 1910. No. 14576.

Electric Power.

The Earthed Concentric System for Direct-Current Colliery Cables. W. Bolton Shaw. Read before the Inst. of Min. Elec. Engrs. Discusses insulating methods of installation, and special points to be observed. General discussion. 8500 w. Ir & Coal Trds Rev—June 17, 1910. No. 15249 A.

Explosions.

Explosions from Coal Dust in English Mines. James Stead. Describes experiments made and states the facts established. 3000 w. Min Wld—June 18, 1910. No. 15007.

See also Testing Stations, under COAL AND COKE.

Geological Predictions.

Geological Predictions—A Mystery to Many. Arthur Lakes. Explains how a geologist predicts the presence of coal, oil, artesian water, etc., at a certain depth when there are no surface indications. Ills. 2500 w. Min Wld—June 4, 1910. No. 14587.

Kansas.

The Kansas State Coal Mine. C. M. Young. Describes methods at a mine where convicts are employed to mine coal for state institutions. 2500 w. Eng & Min Jour—June 4, 1910. No. 14575

Mine Dust.

An Analysis of the Coal Dust Problem. Audley H. Stow. Showing the quantity of dust necessary to produce an explosion, and giving suggestions for greater safety. 5000 w. Eng & Min Jour—June 18, 1910. No. 14988.

Some Memoranda Concerning Coal Dust and the Essential Principles of the Coal-Dust Theory. A. W. G. Holbaum. From a paper read before the Inst. of Min. Engrs. An explanation of the coal-dust theory and the remedies. 2500 w. Col Guard—June 3, 1910. No. 14744 A.

Experiments Illustrative of the Inflammability of Mixtures of Coal Dust and Air. P. Phillips Bedson. Read before the Inst. of Min. Engrs. Report of experiments and results. 2500 w. Ir & Coal Trds Rev—June 3, 1910. No. 14760 A.

Coal-Dust Experiments at the Testing Gallery in the Rossitz District (Versuche mit Kohlenstaub im Versuchsstollen des Rossitzer Steinkohlenreviers). Herrn. Czaplinski and Jicinsky. Second report. Ills. Serial. 1st part. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen—May 28, 1910. No. 14868 D.

Mine Gas.

A Study of Flame Caps. George Hiram Winstanly. Describes apparatus for demonstrating the height of flame cap produced by a given percentage of gas. 5000 w. Mines & Min—June, 1910. No. 14565 C.

Mine Shops.

General Lay-Out and Equipment of a Complete Set of Engineering Shops for a Modern Colliery, with an Output of About 2000 Tons Per Day. C. W. Jordan. Second Lewis prize paper. Read before the S. Wales Inst. of Engrs. Ills. 3500 w. Ir & Coal Trds Rev—May 27, 1910. No. 14630 A.

Mining.

Present Greatest Need of Mining. J. T. Beard. Considers existing conditions and some remedies. 3800 w. Mines & Min—June, 1910. No. 14562 C.

Coal Mining by the Monks. Presidential address before the Inst. of Min. Engrs. Reviews coal mining from its earliest beginnings, especially when chiefly carried on by the monks. 7000 w. Col Guard—June 3, 1910. No. 14746 A.

Methods of Mining Lignite in Italy. Charles R. King. Illustrates and describes the methods used. 4500 w. Eng & Min Jour—June 4, 1910. No. 14579.

Method of Working a Steep Coal Seam. Austin Y. Hoy. Gives details of a system used at Coal Creek mine in a seam pitching 38 degrees. 2000 w. Eng & Min Jour—June 25, 1910. No. 15202.

Safety Precautions in Alabama Coal Mines. E. A. Coxe. The electric shot firing system and mechanical means for getting coal are being adopted. Ills. 2500 w. Eng & Min Jour—June 4, 1910. No. 14577.

Mining Costs.

The Cost of Producing Coal. H. F. Bulman. Detailed discussion of the elements of cost. 2500 w. Col Guard—May 19, 1910. No. 14463 A.

Mining Plants.

See Shaft Sinking, under MINING.

Netherlands.

A Comparative Study of the Coal Fields of Northern Europe. John Kirsopp, Jr. A study based upon the memoirs recently published by the Government Institute for the Geological Exploration of the Netherlands. Map. Editorial. 3500 w. Min Jour—May 21, 1910. Serial. 1st part. No. 14453 A.

Nova Scotia.

Coal Mining in Pictou County, Nova Scotia. J. R. Rutherford. Illustrates and describes the coalfield and its development. 4500 w. Jour Can Min Inst—1909. No. 15181 N.

The Caledonia Coal Mine, Dominion No. 4, Glace Bay, C. B. Eugene P Cowles. Illustrated description of the mine and methods. 5000 w. Jour Can Min Inst—1909. No. 15177 N.

Origin.

A Geologist's Notes on the Origin of Coal. J. A. Udden. Read before the Nat. Assn, of San. Engrs. Explains briefly the geological explanation of the origin as at present understood. 3000 w. Min Wld—June 4, 1910. No. 14590.

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The Alteration of Vegetable Matter Into Coal. D. B. Dowling. Discusses conditions which may have influenced the transformation and caused variations. 2800 w. Qr Bul Can Min Inst—April, 1910. No. 15186 N.

Peat.

See Gas-Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Pennsylvania.

The Northern Appalachian Coalfield. Rush N. Hosler. A detailed study of the various seams and the general character of the basin. 3500 w. Eng & Min Jour—May 28, 1910. No. 14426.

Rescue Appliances.

Oxygen Breathing Apparatus in Coal Mines with a Paragraph on the Rescue Station of the Dominion Coal Co., Glace Bay, Cape Breton. F. W. Gray. Outlines the history of breathing apparatus and its use, describing types. Discussion. 4500 w. Jour Can Min Inst—1909. No. 15163 N.

Rescue Chambers.

Refuge Chamber in Mines. Plans and description prepared by Jesse J. Johnson and presented in course of a debate on mine rescue work at Washington. Ills. 1000 w. Min & Sci Pr—June 18, 1910. No. 15148.

Testing Stations.

The Liévin Testing Station (La Station d'Essais de Liévin). J. Taffanel. Describes an important station in France for the investigation of the causes of mine explosions. Ills. 6000 w. Mem Soc Ing Civ de France—March, 1910. No. 14811 G.

Washing.

The Mechanical Preparation of Coal. H. H. Stoek. Abstract of a paper read before the Int. Ry. Fuel Assn. Considers the aim in the treatment and methods employed. 5500 w. Min Wld—June 11, 1910. No. 14710.

West Virginia.

Coal Mining at Morgantown, West Virginia. R. B. Brinsmade. Describes the mines, haulage system, methods of mining and related matters. Ills. 1800 w. Eng & Min Jour—June 11, 1910. No. 14700.

COPPER.

Alaska.

The Kennicott Bonanza Copper Mine, Alaska. L. W. Storm. Illustrated description of this mine and facts relating to it. 2500 w. Eng & Min Jour—June 11, 1910. No. 14697.

British Columbia.

The Mineral Resources of the Queen Charlotte Islands. J. McLellan. Describes the extensive mineralization, as yet undeveloped. 3000 w. Qr Bul Can Min Inst—April, 1910. No. 15188 N.

California.

The Occurrence of Copper in Shasta County, California. L. C. Graton. A preliminary statement of the features of the Shasta County copper region and some of the general conclusions reached. Map. 18000 w. U S Geol Surv—Bul. 430-B. No. 14644 N.

The Balaklala Mine and Smelter, California. A. H. Martin. Illustrates and describes these copper mines and their development. 3500 w. Min Wld—June 11, 1910. No. 14708.

Chile.

Copper Mining & Smelting in the District of Los Bronces, Santiago, Chile. J. Blanquier. Information concerning these copper deposits, their mining and treatment. 1200 w. Min Jour—June 4, 1910. No. 14736 A.

Converters.

Copper Converters with Basic Lining. Redick R. Moore. Discusses the operation of basic lined converters, stating the advantages and disadvantages, and considering the Peirce and Smith patent claims. 5000 w. Eng & Min Jour—June 25, 1910. No. 15199.

Idaho.

Geology of the Copper Deposits Near Montpelier, Bear Lake County, Idaho. Hoyt S. Gale. Describes the geology of the copper-bearing rocks, the occurrence, developments, etc., and gives a summary and conclusions. Map. 3000 w. U S Geol Surv—Bul. 430-B. No. 14645 N.

Mexico.

Los Pilares Mine, Nacozari, Mexico. Courtenay De Kalb. Illustrated account of mining methods of interest at this important copper mine. 2500 w. Min & Sci Pr—June 18, 1910. No. 15147.

Montana.

The Corbin District, Jefferson County, Montana. Floyd Bushnell. Mines now developing copper ores were formerly large producers of silver. Ills. 2000 w. Eng & Min Jour—June 4, 1910. No. 14573.

Nevada.

Present Conditions at Ely. Illustrated account of operations at these copper mines, the milling and smelting plants and methods of mining. 1800 w. Min & Sci Pr—June 11, 1910. No. 14974.

Nova Scotia.

Notes on the Copper Lake Mine, Antigonish, N. S. John W. McLeod. History and illustrated description. 2800 w. Jour Can Min Inst—1909. No. 15183 N.

Ontario.

The Mining, Smelting and Power Plants of the Canadian Copper Company. G. E. Silvester. Illustrated detailed description of three plants at Copper Cliff, Ont., for producing nickel. 7500 w. Jour Can Min Inst—1909. No. 15161 N.

Pennsylvania.

The Copper Deposits of South Mountain in Southern Pennsylvania. George W. Stose. The geology, ore deposits, and origin of the ore. Map. 4000 w. U S Geol Surv—Bul. 430-B. No. 14646 N.

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Production.

Copper Through Fifty Years. James Douglas. A brief review of the industry since the middle of the last century. 3000 w. Min & Sci Pr—May 21, 1910. No. 14432 C.

Smelter Fumes.

Smeltery Smoke as a Source of Sulphuric Acid. W. H. Freeland and C. W. Renwick. Illustrated description of a plant at Ducktown, Tenn., utilizing blast furnace gas. 2500 w. Eng & Min Jour—May 28, 1910. No. 14425.

Smelting.

Fifty Years of Smelting in the Western States. L. S. Austin. Discusses especially the development of lead and copper smelting and comparisons made with present practice. 2500 w. Min & Sci Pr—May 21, 1910. No. 14438 C.

Some Western Metallurgical Problems. A. W. Warwick. Abstract of a paper read before the West. Assn. of Tech. Chem. & Met. Considers some processes suggested for the treatment of complex sulphide ores, oxidized copper ores, and tailings. 5000 w. Min Wld—June 11, 1910. No. 14709.

GOLD AND SILVER.

Amalgamation.

See Tailings, under ORE DRESSING AND CONCENTRATION.

Arizona.

A Silver Bearing Diorite in Southern Arizona. Josiah Bond. Describes a new occurrence of silver. 1500 w. Eng & Min Jour—June 18, 1910. No. 14983.

The Kingman Mining District of Arizona. Walter Harvey Weed. Descriptive account of the region and its mining properties. 2500 w. Min Wld—June 4, 1910. No. 14586.

Australia.

The Gold Production of Western Australia. John Plummer. Reports a steady decline in production since 1903. 1800 w. Min Wld—June 11, 1910. No. 14711.

Mount-Spencer Gold and Mineral Field. Lionel C. Ball. Illustrated account, with special reference to its copper mines. 4500 w. Queens Gov Min Jour—May 14, 1910. No. 15222 B.

Eungella Goldfield. Lionel C. Ball. Abridged field notes with sketch plan. 5000 w. Queens Gov Min Jour—April 15, 1910. No. 14605 B.

Yerranderie Silver Field, New South Wales. E. F. Pittman. Describes the occurrence of native silver, and reports the nine mines now working. 2000 w. Aust Min Stand—May 4, 1910. No. 14603 B.

The Neglected Ovens District Goldfields (V.). An account of this extensive auriferous region. The present article discusses the production. Map. 3000 w. Aust Min Stand—April 20, 1910. Serial. 1st part. No. 14600 B.

British Columbia.

Mining in Atlin, British Columbia, 1898-1908. Rosalind Watson Young. Reviews the history of the ten years. Ills. 4500 w. Jour Can Min Inst—1909. No. 15173 N.

Recent Mining Developments on the Skeena River. W. W. Leach. An account of prospecting on an area tributary to the projected line of the Grand Trunk Pacific railway. 2000 w. Qr Bul Can Min Inst—April, 1910. No. 15190 N.

The Portland Canal Mining District. R. W. Thomson. Describes a promising mining district of the Pacific Coast. 2000 w. Qr Bul Can Min Inst—April, 1910. No. 15191 N.

Mineral Resources of the "Lardeau," British Columbia. Newton W. Emmens. Treats the subject from an economic standpoint. Deposits of gold, silver, lead and zinc ores are known. Ills. 8800 w. Jour Can Min Inst—1909. No. 15172 N.

Gold Ores of the Lardeau District, B. C. Newton W. Emmens. Illustrated description of quartz veins and their development. 3000 w. Min Wld—June 25, 1910. No. 15214.

California.

Mining on the Mother Lode in Amador County, California. William H. Storms. Interesting review of the history of the Eureka-Badger vein. 3500 w. Min & Sci Pr—June 18, 1910. No. 15150.

Cobalt.

Diabase and Aplite of the Cobalt-Silver Area. N. L. Bowen. Presents results of Chemical and microscopic examination of samples. 3000 w. Jour Can Min Inst—1909. No. 15176 N.

Colorado.

Lessons from Stratton's Independence, Colo. Shows how low-grade dump material was handled at a profit. Ills. 1500 w. Min Wld—June 18, 1910. No. 15005.

Cyaniding.

Proposed Simplification of the Cyanide Process. Bruno Mierisch. Outlines two schemes whereby filtering, fillet-pressing and zinc-box precipitation may be avoided. 1200 w. Eng & Min Jour—June 25, 1910. No. 15201.

Improvements in the Cyanide Process. Bernard MacDonald. Brief review of improvements in the mechanical manipulation of the ore-pulp during treatment, and in methods of recovering the metals. Ills. 2000 w. Min & Sci Pr—May 28, 1910 No. 14539.

Rapid Anaylsis of Commercial Cyanide. Ralston Bell. Explains the process and the calculation, illustrating by examples. 1800 w. Eng & Min Jour—May 28, 1910. No. 14424.

Dredging.

Gold Dredging in British Columbia. Arthur E. Hepburn. Compares conditions with those existing in other countries, indicating the causes for the non-success. Ills. 3000 w. Jour Can Min Inst—1909. No. 15174 N.

See also Korea, under GOLD AND SILVER.

Electrolytic Refining.

Electrometallurgy at Philadelphia Mint. H. J. Slaker. Illustrates and describes the electrolytic parting and refining of bullion in the U. S. mints. 2500 w. Elec Wld—June 23, 1910. No. 15136.

Korea.

Dredging Possibilities in Korea. R. Y. Hanlon. An illustrated article giving information in regard to the placers and the methods of working. 1200 w. Min & Sci Pr—June 4, 1910. No. 14671.

Madagascar.

The Industrial Development of Madagascar (Madagascar, son Développement industriel). M. Ratel. Discusses particularly the gold-mining industry. Ills. 4500 w. Tech Mod—May, 1910. No. 14825 D.

Mexico.

The Mapimi Mining District, Durango, Mexico. Illustrated description of mines yielding gold, silver and lead. 1600 w. Min Wld—June 25, 1910. No. 15216.

The Mines of the Altar District, Sonora, Mexico. Charles A. Dinsmore. Describes the working of the placers, the ore treatment, and the quartz mines. Ills. 2500 w. Min Wld—May 28, 1910. No. 14427.

Ontario.

First Year of the Gowganda District, Ontario. G. M. Colvocoresses. An illustrated account of the first year of development. 3000 w. Eng & Min Jour—June 11, 1910. No. 14696.

Porcupine Gold Field's Developments to Date. Alex. Gray. Illustrated report of Ontario's latest mining field. 1800 w. Min Wld—June 4, 1910. No. 14589.

The Porcupine Gold Area. W. E. H. Carter. An illustrated account of a recent visit to the district, describing the deposits and conditions. 2000 w. Can Min Jour—June 15, 1910. No. 15000.

See also Sampling, under ORE DRESSING AND CONCENTRATION.

Quebec.

The Chibogomou Region, Province of Quebec. E. Dulieux. Reports concerning the geology, mineral deposits, and the desirability of uniting the district by a line of railway. Ills. 3000 w. Jour Can Min Inst—1909. No. 15160 N.

Utah.

Mines and Mill of the Consolidated Mercur Co. Roy Hutchins Allen. Describes the deposits, and the successful cyanidation of complex refractory ores. Ills. 5000 w. Eng & Min Jour—June 18, 1910. No. 14985.

IRON AND STEEL.

Analysis.

The Titration of Permanganate with Arsenic Acid in Neutral or Slightly Alkaline Solutions (Ueber die Titration von Permanganat mit arseniger Säure in neutralen oder schwach alkalischen Lösungen). Eugen Deiss. Reports the results of an extended research. 3700 w. Stahl u Eisen—May 4, 1910. No. 14860 D.

Bessemer.

Sir Henry Bessemer, a Great Inventor (Un grand Inventeur: Sir Henry Bessemer). Henry Le Chatelier. A review and appreciation of Bessemer's work, with lists of his inventions, correspondence, etc. Ills. 15000 w. Rev de Métal—May, 1910. No. 14813 E + F.

Blast-Furnace Practice.

The Agglomeration Process at the Fernie Works, Giessen (Das Agglomerierverfahren auf den Fernie-Werken bei Giessen). Friedrich Witte. Describes a process for consolidating friable iron ore before charging into the blast furnace. Ills. 3000 w. Stahl u Eisen—May 4, 1910. No. 14859 D.

Blast Furnaces.

The New Earlston Furnace. Illustrates and describes features of top construction and of bottom filling in a furnace at Everett, Pa. 1200 w. Ir Age—June 23, 1910. No. 15115.

The Thin-Lined Water-Cooled Blast Furnace. Section and description of a change in construction methods which gives promise of good results. 1400 w. Ir Trd Rev—June 16, 1910. No. 14961.

Blowing Engines.

Gas-Driven Blowing Plant at the Works of Messrs. Vivian & Sons, Swansea. Illustrated description. 2000 w. Ir & Coal Trds Rev—May 27, 1910. No. 14631 A.

China.

Iron and Steel Works at Hanyang, Hupe, China. A. J. Seltzer. Illustrated description of the works and their equipment. 2500 w. Eng & Min Jour—June 11, 1910. No. 14698.

Electrometallurgy.

The Electric Furnace and the Electrometallurgy of Iron and Steel. A. Stansfield. Abstract of a lecture describing types of furnace used. Ills. 1500 w. Jour Can Min Inst—1909. No. 15171 N.

The Electric Furnace in the Iron and Steel Industry. G. Hooghwinkel. Read before the Sheffield Soc. of Engrs. & Met. Gives results obtained with various types of electric furnaces both for smelting and refining work. 4000 w. Elect'n, Lond—June 3, 1910. No. 14730 A.

Tool Steel Direct from the Ore in an Electric Furnace. Alfred Stansfield. Read before the Can. Min. Inst. An account of experimental work in the plant of J. W. Evans. Ills. 2500 w. Can Min Jour—June 15, 1910. No. 15001.

The Electric Steel Furnace (Beitrag zum Studium der Elektrostahlofen). A discussion of hearth materials and construction. Ills. Serial. 1st part. 1000 w. Elektrochem Zeitschr—May, 1910. No. 14856 D.

England.

Cleveland Ironstone and Iron. J. E. Stead. Abstract from a paper read be-

fore the Cleveland Inst. of Engrs. Illustrated article describing the microstructure and discussing the genesis, and interesting feature. 5000 w. Ir & Coal Trds Rev—May 20, 1910. No. 14480 A.

Germany.

The Iron-Ore Resources of Germany (Die Eisenerzvorräte des Deutschen Reiches). F. Beyschlag, G. Einecke and W. Köhler. A detailed study of the various districts. Ills. 22000 w. Stahl u Eisen—May 25, 1910. No. 14862 D.

Michigan.

Michigan Iron Mines and Their Mine Waters. Alfred C. Lane. Gives a general description of the ores and the theories of their origin and a study of interesting mine waters. 4500 w. Jour Can Min Inst—1909. No. 15158 N.

Newfoundland.

See Slopes, under MINING.

Ontario.

The Wilbur Iron Mine. Shirley King. Describes the deposit and the geology. 3000 w. Jour Can Min Inst—1909. No. 15179 N.

Open-Hearth Furnaces.

Sunday Rest in Open-Hearth Plants (Die Sonntagsruhe in den Martinwerken). Discusses the effect of suspension of operations on Sunday, with special reference to recent German legislation. 5600 w. Stahl u Eisen—May 4, 1910. No. 14857 D.

Open-Hearth Plants.

The Installation of an Open-Hearth Steel Plant (Installation d'une Aciérie Martin). E. Davin. A brief discussion of the equipment required and its arrangement in the plant. 3000 w. All Indus—May, 1910. No. 14832 D.

Ore Prices.

The Market Price of Different Kinds of Iron Ore. Prof. T. M. L. Vogt. On appendix to the report of the Norwegian Elec. Met. Committee, discussing the factors which determine the price. 2200 w. Ir & Coal Trds Rev—May 27, 1910. No. 14632 A.

Rolling Mills.

New McKeesport Tin Plate Mills. Illustrated account of the remarkably rapid construction of an addition to this plant. 1500 w. Ir Age—June 23, 1910. No. 15118.

Russia.

Some Important Factors in the Russian Iron and Coal Trades. Charles J. Smith. An explanation of the present condition of these industries and the recent changes. 3500 w. Ir & Coal Trds Rev—May 27, 1910. No. 14629 A.

Steel Making.

Putting Carbon into Steel. Philo Kemery. Describes various methods of adding carbon to steel to obtain different grades. 3500 w. Am Mach—Vol. 33. No. 25. No. 15129.

Transvaal.

Report of F. W. Harbord on the Manufacture of Iron and Steel in the Transvaal. Gives report as published by the Government. 3000 w. Engr, Lond—May 27, 1910. Serial. 1st part. No. 14628 A.

LEAD AND ZINC.

Lead Smelting.

Lead and Zinc Smelting in Upper Silesia. O. H. Hahn. A review of 20 years' progress, the development of the Huntington-Heberlein process, and the state-controlled smelteries. 3500 w. Eng & Min Jour—May 28, 1910. No. 14423.

Early Smelting at Cerro Gordo. Francis Drake. An account of early smelting of the silver-lead ores, and the waste because of methods used. 1500 w. Min & Sci Pr—May 21, 1910. No. 14437 C.

See also Smelting, under COPPER.

Missouri.

Mining on a Royalty Basis. Lucius L. Wittich. Illustrated article discussing methods and cost of mining in the Joplin district. 4500 w. Mines & Min—June, 1910. No. 14560 C.

Wisconsin.

Empire-Enterprise Zinc Mines, Wisconsin. Harold C. George. Gives the geology, history, and mining equipment and methods. Ills. 2000 w. Eng & Min Jour—June 18, 1910. No. 14987.

Zinc Smelting.

See Lead Smelting, under LEAD AND ZINC.

MINOR MINERALS.

Antimony.

The Wheaton River Antimony Deposits, Yukon Territory. D. D. Cairnes. Describes these recently discovered deposits. Ills. 4000 w. Qr Bul Can Min Inst—April, 1910. No. 15189 N.

Arsenic.

Arsenic Manufacture at Midvale, Utah. Leroy A. Palmer. Illustrated description of a plant for roasting arsenic ores and condensing and refining the fume. 3300 w. Mines & Min—June, 1910. No. 14555 C.

Asbestos.

Notes on Recent Developments in Asbestos Mining in Quebec. W. J. Woolsey. Describes geological features, mining and milling methods. Ills. 1500 w. Qr Bul Can Min Inst—April, 1910. No. 15192 N.

Notes on the King Bros.' Asbestos Mine, Thetford, Quebec. Ezra B. Rider. Gives the topography, geology, history and statistics, with description. Ills. 4000 w. Jour Can Min Inst—1909. No. 15182 N.

Cement.

Combustion in Cement-Burning. Byron E. Eldred. A critical study of the present practice of burning cement, and suggesting the use of a gas-fired rotary kiln. 4500 w. Bul Am Inst of Min Engrs—June, 1910. No. 15094 F.

See also same title, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Chromite.

Chrome Bearing Peridotites of Lake

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Abitibi. H. T. White. Describes the chromite ore bodies. 1600 w. Jour Can Min Inst—1909. No. 15180 N.

Clays.

The Geological Investigation of Clays. Heinrich Ries. Remarks on the importance of this material, its uses, value, and the methods of geological investigation. 1800 w. Jour Can Min Inst—1909. No. 15166 N.

Prospecting and Testing of Clay Deposits. E. K. Soper. Information concerning their distribution and value, method of testing, etc. 3500 w. Min & Sci Pr—June 4, 1910. No. 14670.

Diamonds.

Prospecting for "Black Diamonds." A. S. Atkinson. Describes conditions and methods of mining in Bahia, Brazil, the only place where they occur. 2200 w. Mines & Min—June, 1910. No. 14556 C.

Fireclay.

The Mining and Fabrication of Fireclay. A. S. B. Little. An illustrated article aiming to arouse the interest of engineers and manufacturers in the improvement of this industry. 3500 w. Engineering Magazine—July, 1910. No. 15260 B.

Lithium.

Lithium and Its Sources. Frank L. Hess. Information concerning this alkaline metal—the lightest known solid element. Ills. 2200 w. Min & Sci Pr—June 4, 1910. No. 14669.

Natural Gas.

See Oil, under MINOR MINERALS.

Nickel.

See Ontario, under COPPER.

Oil.

A Rapid Method for the Indentification of Gas Oils. F. E. Park and L. E. Worthing. Read before the Am. Gas Inst. Reviews briefly the chemical composition of petroleum, and describes a process of bromination. Short discussion. 3500 w. Pro Age—June 1, 1910. No. 14412.

The Conditions of Accumulation of Petroleum in the Earth. David T. Day. A summary of information obtained upon the variations in color and specific gravity as found in different places, and also variations in chemical composition. 2000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15096 F.

The Use of Geological Science in the Petroleum and Natural Gas Business. Frederick G. Clapp. An explanation showing geology to be of great value to the oil and gas operator. Ills. General discussion. 10500 w. Pro Engrs' Soc of W Penn—May, 1910. No. 15046 D.

The California Oil Industry. Courtenay De Kalb. Abstract of an address at meeting of the California Development Board. Remarks on the wonderful development, describing the oil fields, and giving much information. 3500 w. Min & Sci Pr—June 11, 1910. No. 14971.

Significance of Oil Refining in Louisiana. David T. Day. First of a series of articles on the oil and gas development of Louisiana and Texas. Ills. 5000 w. Mfrs' Rec—June 23, 1910. Serial. 1st part. No. 15108.

Developments of a New Texas Oil Field. Charles A. Dinsmore. Brief account of the development of the property of the Producers' Oil Co. at Toyah, Texas. 1500 w. Min Wld—June 4, 1910. No. 14588.

The Oil Excitement in Mexico. H. S. Denny. Gives information gathered during a recent tour of inspection dicussing the controversy of the Pearson and Waters-Pierce companies. 4000 w. Min Jour—June 4, 1910. No. 14737 A.

Russian Petroleum. Reviews the conditions in the old oil fields, the new discoveries, and the production. 2500 w. Mines & Min—June, 1910. No. 14558 C.

The Oilfields of New Zealand. Maps and descriptions of the districts. 1600 w. Min Jour—June 11, 1910. Serial. 1st part. No. 15035 A.

Leinweber Method of Extracting Oil from Wells. Frederick A. Talbot. The main feature is an endless cable carrying absorbent material, which delivers 7 oz. of oil per foot of cable. Ills. 1200 w. Eng & Min Jour—June 18, 1910. No. 14984.

Phosphates.

Guano and Phosphate Deposits of the Pacific Ocean (Les Gisements de Guano et de Phosphates de l'Océan Pacifique). Paul Privat-Deschanel. Discusses their location, extent, exploitation, origin, etc. 3200 w. Génie Civil—May 21, 1910. No. 14841 D.

Plaster of Paris.

A Comparative Study of the Classic Kiln Method of Making Plaster of Paris and the Périn Process (Etude comparée sur le Procédé classique de Fabrication du Plâtre dit des "Fours culées" et le Procédé Périn). L. Périn. Ills. 6000 w. Mem Soc Ing Civ de France—March, 1910. No. 14812 G.

Precious Stones.

Some Ancient Ideas Regarding Gems. Gordon Surr. Information from the work on "Gems and Gem Minerals" by O. C. Farrington. 2500 w. Min Wld—June 25, 1910. No. 15215.

Rare Earths.

The Rare Earths and Incandescent Lighting (Les Terres rares et l'Eclairage à l'Incandescence). Capt. Nicolardot. Discusses their discovery, properties, mining, and application in the manufacture of incandescent gas mantles, describing the processes and various types of gas lamp. Ills. 12500 w. Bul Soc d Encour—April, 1910. No. 14816 G.

Salt.

New Salt Works in Cheshire. Brief illustrated description of works at Weston

We supply copies of these articles. See page 807.

Point, and improvements at Winsford. 1500 w. Engr, Lond—June 10, 1910. No. 15038 A.

Statistics of the Alpine Salt Industry (Statistische Mitteilungen über den Betrieb der alpinen Salinen). Anton Schnable. A review of the industry since 1950. 5000 w. Oest Zeitschr f Berg u Hüttenwesen—May 14, 1910. No. 14866 D.

Structural Materials.

Field Investigations of Structural Materials by the U. S. Geological Survey. Ernest F. Burchard. Gives account of the work, explaining its aims. 1500 w. Bul Am Inst of Min Engrs—June, 1910. No. 15098 F.

Tin.

Fifty Years in Cornwall. Thomas Rickard. Brief review of improvements introduced in drainage, dressing methods, etc., and remarks on needed improvements and the present conditions. 3000 w. Min & Sci Pr—May 28, 1910. No. 14538.

Reminiscence of Mining in Cornwall. Joseph Vivian. An account of the mining of copper and of tin and the history of the mines. 2500 w. Min & Sci Pr—May 21, 1910. 14436 C.

Tourmaline.

Tourmaline in California. John L. Cowan. Information in regard to the deposits and their value. 2200 w. Min & Sci Pr—June 11, 1910. No. 14973.

Tungsten.

Ductile Tungsten. W. D. Coolidge. Outlines the difficulties met in the mechanical working of tungsten, and the final success. 1800 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14959 F.

MINING.

Accidents.

Mining Accidents and the Rendering of First Aid. Charles H. Hair. Brief consideration of avoidable and unavoidable accidents and directions for first aid. 2000 w. Jour Can Min Inst—1909. No. 15165 N.

Mine Accidents. E. T. Corkill. A study of the causes and the prevention. Discussion. Ills. 6000 w. Jour Can Min Inst—1909. No. 15164 N.

Accounting.

Mine Accounting (Kaufmännische und kameralistische Buchführung für Bergwerke). Herr Witte. A complete scheme for a set of mine accounts. Ills. 7000 w. Glückauf—May 7, 1910. No. 14870 D.

Ankylostomiasis.

Ankylostomiasis in Austria and Combative Measures (Die Wurmkrankheit—Ankylostomiasis—in Oesterreich und ihre Bekämpfung). Arpad Kriz. Discusses the extent of the disease and methods of prevention. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—May 7, 1910. No. 14864 D.

Bore Holes.

Measurements of the Increase of Temperature in Bore-Holes with the Depth; the Technics and Practical Importance of Same for Geological Prognosis. Joh. Koenigsberger and M. Muhlberg. Read before the Inst. of Min. Engrs. Explains method of measurements, giving conclusions and results. 3500 w. Ir & Coal Trds Rev.—June 3, 1910. No. 14761 A.

Boring.

Use of the Terry Core Drill in Mine Operations. Cores 30-inches in diameter have been obtained. A number of 20-inch bore holes are being sunk at Hermon, N. Y. Gives advantages, cost, etc. Ills. 1800 w. Eng & Min Jour—June 4, 1910. No. 14574.

Diamond Drilling.

Drill Core Problems. Alfred C. Lane. Explains a method of calculating the positions of strata from indications on cores. 1500 w. Mines & Min—June, 1910. No. 14561 C.

Drills.

History of the Rock Drill. W. L. Saunders. An account of its invention and development. 1200 w. Min & Sci Pr—May 21, 1910. No. 14433 C.

The Wolski Hydraulic Rock Drill. F. A. Talbot. Describes a drill which utilizes the water hammer effect when a moving column of water is suddenly stopped. 1800 w. Eng & Min Jour—June 18, 1910. No. 14986.

Electric Hoisting.

Electrically Driven Winding Engine. An extensive electrical installation at the Harton Colliery, England, is illustrated and described. 1200 w. Engr, Lond—June 17, 1910. No. 15244 A.

Electric Power.

Application of Electricity in Mines in Europe. R. Nelson. Explains grounds for preferring 3-phase alternating current, discussing the requirements for safety. 2800 w. Min Wld—June 25, 1910. No. 15218.

Erection and Maintenance of Electrical Plant on a Gold Mine. W. Elsdon Dew. Deals with various phases of practical work on a gold mine. 2000 w. Elec Engr, Lond—May 20, 1910. No. 14445 A.

Gas Power.

Some Notes on Gas Power and Its Applicability to Mining. A. Burnett. Remarks on the status of the gas engine, outlining the philosophy of the gas producers. Discussion. 5000 w. Jour Can Min Inst—1909. No. 15162 N.

Haulage.

The Evolution of Mine Haulage. An illustrated review of means of transporting ore in various parts of the world. 4000 w. Mines & Min—June, 1910. No. 14563 C.

See also Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Head Frames.

Types of Head Frames on the Mother Lode. William H. Storms. Illustrations with short descriptions. 1500 w. Min Wld—June 18, 1910. No. 15002.

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Hoisting.

Frictional Resistances in Hoisting Plants (Reibungswiderstände bei Förderanlagen). J. Havlicek. Reports tests on an Ilgner plant. Ills. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—May 21, 1910. No. 14867 D.

Hoisting Cages.

Intermediate Gears on Hoisting Cages (Die Auswechselung der Zwischengeschirre an Förderkörben). Herr Busse. Discusses materials and design for safe construction. 3000 w. Glückauf—May 21, 1910. No. 14874 D.

Law.

Deficiencies in Canadian Mining Laws. H. Mortimer Lamb. Read before the Can. Min. Inst. Critical discussion of some existing regulations. 3000 w. Min Wld—June 18, 1910. No. 15006.

Some Notes on the Mining Laws of Ontario. J. Lorn McDougall. Discussion. 4000 w. Jour Can Min Inst—1909. No. 15169 N.

Seventy Years of Mining Legislation. G. W. Chrystall. From the Second Report of the Royal Commission on Mines. A review. 7500 w. Ir & Coal Trds Rev—May 20, 1910. No. 14481 A.

The Law of Mineral Rights in Germany (Die rechtmässige Gewinnung bergfreier und fremder Mineralien). Herr Lohmann. A discussion of certain important points. Ills. Serial. 1st part. 10500 w. Glückauf—May 21, 1910. No. 14875 D.

Mine Cars.

The Summers Motor Driven Ore Car. Brief illustrated description of a car built for the Int. Smelting & Refining Co. 500 w. Ir Age—June 9, 1910. No. 14651.

Mine Locomotives.

Electric Tramming at Iron Mines. Illustrated description of the single-motor locomotive used for tramming in the deep iron mines of the Lake Superior ranges. 1200 w. Ir Age—June 2, 1910. No. 14484.

Mine Telephones.

Telephone Practice in Mines and on Railways. Illustrated description of a system for transmitting instructions from the surface to underground works. 3500 w. Elec Engr, Lond—May 20, 1910. No. 14444 A.

Mine Waters.

See Michigan, under IRON AND STEEL.

Prospecting.

Some Ideas Prevalent Among Prospectors. Gordon Surr. Considers notions more or less common. 1700 w. Min Wld—June 18, 1910. No. 15004.

Sanitation.

The Sanitation of Mines in Respect to Human Dejecta. Henry Kenwood. From a paper in the *Trans. of the Roy. Inst. of Pub. Health.* Explains the danger from polluted dust and considers means to prevent contamination. 2500 w. Col Guard—May 27, 1910. No. 14616 A.

Shafts.

The Giroux Shaft at Kimberly, Nevada. C. Everard Arnold. Describes the five-compartment shaft and its construction. Ills. 800 w. Eng & Min Jour—June 25, 1910. No. 15200.

The Giroux Shaft at Kimberly, Nev. C. Everard Arnold. Illustrated description of the five-compartment shaft which will serve the Alpha mine. 1000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15095 F.

The Best Form of Shaft Tubbing (Ueber die zweckmässigste Tübbingform). L. Maduschka. Criticises Herr Heise's article in *Glückauf*, with correspondence between the two authors. Ills. 4000 w. Glückauf—May 7, 1910. No. 14871 D.

Shaft-sinking.

Sinking the Woodward No. 3 Shaft. R. V. Norris. Illustrates and describes unusual methods required to sink through gravel and quicksand saturated with water. 3500 w. Eng & Min Jour—June 4, 1910. No. 14580.

The Sinking of the Astley Green Shafts at Astley, near Manchester, by Means of the Drop-Shaft Method and Under-Hanging Tubbing. Charles Pilkington and Percy Lee Wood. Abstract of a paper read before the Manchester Geol. & Min. Soc. Illustrated detailed description of the work. 3000 w. Ir & Coal Trds Rev—June 17, 1910. No. 15248 A.

The Sinking and Equipment of the Littleton Collieries. T. H. Bailey. Describes the geological features, early operations, unwatering and sinking. equipment and plant. Ills. 9500 w. Col Guard—June 17, 1910. No. 15234 A.

The Sinking and Equipment of the Littleton Collieries. Thomas Henry Bailey. Abstract of paper read before the S. Staffordshire & Warwickshire Inst. of Min. Engrs. Illustrated description of the unwatering and sinking, and the surface equipment and plant. 4500 w. Ir & Coal Trds Rev—June 10, 1910. No. 15039 A.

Slopes.

The Sinking of the Wabana Submarine Slopes. An account of the development of under-sea deposits of iron ore in Newfoundland. 3000 w. Jour Can Min Inst—1909. No. 15159 N.

Surveying.

Modern Method of Plumbing a Shaft. John P. Davis. Gives details of the system employed in the anthracite fields, where steel wires are preferred to copper, and the plummets immersed in an oil bath. Ills. 1200 w. Eng & Min Jour—June 4, 1910. No. 14578.

Taxation.

The Probable Effect of the Acreage Tax on Mining Lands in Ontario. G. R. Mickle. A forecast. Discussion. 9000 w. Jour Can Min Inst—1909. No. 15168 N.

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Unwatering.

Reclaiming Flooded Drift Mines in Alaska. W. H. Lanagan. Describes three different methods put in practice in the Nome district. Ills. 3000 w. Min & Sci Pr—June 18, 1910. No. 15149.

Valuation.

Mine Valuation (Wertschätzung von Bergwerken). A review of a book on this subject by W. Kreutz. 2500 w. Oest Zeitschr f Berg- u Hüttenwesen—May 14 1910. No. 14865 D.

Ventilation.

Proportining Fans to Mines. Thomas W. Fitch, Jr., and J. R. McColl. Illustrates and describes methods of locating fans at shafts and drifts to avoid damage in case of explosion. 1800 w. Mines & Min—June, 1910. No. 14566 C.

ORE DRESSING AND CONCENTRATION.

Concentration.

Calculation of Recovery in Concentration. Theodore J. Hoover. Gives formulae believed to be sound in theory, discussing the possible errors. 1500 w. Eng Min Jour—June 11, 1910. No. 14699.

Filter Presses.

See Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Flocculation.

The Phenomena of Flocculation and Deflocculation. E. E. Free. Outlines the present knowledge of these phenomena as they affect suspension and as they are affected by various external conditions. Ills. 4500 w. Jour Fr Inst—June, 1910. Serial. 1st part. No. 14920 D.

Gold Milling.

The Metallurgy of Gold. Donald Clark. Describes in detail the Edwards' Pyrites Works. Bendigo (V.). 2500 w. Aust Min Stand—April 27, 1910. No. 14601 B.

Treatment of Concentrates at Kalgoorlie, Western Australia. W. M. von Bernewitz. Gives an outline of the process in vogue at the present time. 1800 w. Min Jour—May 21, 1910. No. 14452 A.

Iron.

The Trout Lake Concentrating Mill. J. N. Roherty. Illustrates and describes the concentrating plant at Coleraine, Minn. 1500 w. Wis Engr—June, 1910. No. 14930 D.

Roasting.

Recent Progress in Blast-Roasting. Prof. H. O. Hofman. A review of the present practice of blast-roasting in the United States and Canada, citing characteristic examples. Ills. 8000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15097 F.

Blast and Down Draft Sintering. Redick R. Moore. Discusses the proper name for processes of desulphurization and agglomeration of fine sulphide ores. 1000 w. Met & Chem Engng—June, 1910. No. 14634 C.

Roasting of Ore, Concentrates, Slimes, Etc. J. E. Edwards. Abstract of a paper read before the W. Assn. of Chem. & Met. Explains the object of roasting, the chemistry, discussing furnace design, treatment, etc. 4000 w. Aust Min Stand—May 11, & 18, 1910. 2 parts. 15221 each B.

Sampling.

I. A Suggestion on "Quartering-Down" Large Samples. II. A Note on the Sampling of the Porcupine Ore Bodies. III. Some Notes on the Philosophy of Sampling. Three articles by H. E. T. Haultain, giving personal opinions of the Porcupine gold district. Ills. 4000 w. Can Min Jour—June 15, 1910. No. 14999.

Screen Analysis.

A Standard Series of Screens for Laboratory Testing. Theodore J. Hoover. Suggestions for a system of measurement of the qualitative result of the operation of grinding ore, and presents a mechanical method of making screen anaylses. Ills. 4000 w. Inst of Min & Met, Bul 68—May 19, 1910. No. 14917 N.

Grading Analyses and Their Application. H. Stadler. Notes showing how proportions of certain standard sizes of particles produced in grinding may be valued in units of energy. 3000 w. Inst of Min & Met, Bul 68—May 19, 1910. No. 14918 N.

Silver Milling.

The Washoe Process. A. D. Hodges, Jr. Gives briefly facts relating to its origin and development. 1500 w. Min & Sci Pr—May 21, 1910. No. 14439 C.

Slimes Treatment.

The Treatment of Accumlated Slime, and the Use of Filter Presses for Clarifying Slime Solution and By-Products. John D. O'Hara. Gives experiences in treating accumulated slime by filter presses, compared with the decantation and the Adair-Usher processes. 2000 w. Jour Chem, Met & Min Soc of S Africa—April. 1910. No. 14724 E.

Stamp Mills.

The California Stamp-Mill. Courtenay De Kalb. An illustrated article describing the early mills and their rapid improvement. 2000 w. Min & Sci Pr—May 21, 1910. No. 14434 C.

Tailings.

Values in Dredge and Placer Tailings. Elmer Ellsworth Carey. Remarks on methods of estimating, and the recovery of cost values. 1500 w. Min Wld—June 18, 1910. No. 15003.

MISCELLANY.

Bureau of Mines.

The U. S. Bureau of Mines. Editorial. A critical discussion of its purpose, powers, and influence. 1200 w. Engineering Magazine—July, 1910. No. 15265 B.

Chili.

Mining and Metallurgy in Chili. F. A. Sundt. Information concerning the min-

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eral resources of the country. Map. 2700 w. Mines & Min—June, 1910. No. 14557 C.

Forestry.

The Relation of Mining to Forestry. B. E. Fernow. Urges that an effort be made to prevent needless damage to forests. 2000 w. Jour Can Min Inst—1909. No. 15167 N.

Geological Surveys.

The United States Geological Survey. Robert H. Chapman. Illustrated account of the work undertaken. 7500 w. Qr Bul Can Min Inst—April, 1910. No. 15185 N.

Economic Geology in the United States. Samuel Franklin Emmons. Discusses the early development of mining and the U. S. Government geological work. 5000 w. Jour Can Min Inst—1909. No. 15157 N.

Work of State Geological Surveys. H. Foster Bain. An illustrated article explaining the work and methods. 2500 w. Qr Bul Can Min Inst—April, 1910. No. 15184 N.

Japan.

Metal-Working in Japan. Abstract of a lecture by Prof. W. Gowland, before the Inst. of Metals, on the "Art of Working Metals as Practiced in Old Japan." 3000 w. Engng—May 27, 1910. No. 14621 A.

Mineral Claims.

Wanted—An Inventory of Promising Mineral Claims. R. W. Brock. Explains the advantages of having reliable information and outlines a scheme for recording properties. Discussion. 2500 w. Jour Can Min Inst—1909. No. 15175 N.

Ore Deposits.

Theories of Ore Genesis of Fifty Years ago. S. F. Emmons. An interesting review of the early theories relating to deposits of the precious metals, and the work of the men who advanced them. 5000 w. Min & Sci Pr—May 21, 1910. No. 14435 C.

Genesis of Ores. Joseph Le Conte. Reprinted from this publication's issue of Jan. 24, 1871. 1500 w. Min & Sci Pr—June 4, 1910. No. 14672.

Geochemistry. George Holloway. Discusses the relation between the mineral and the chemical industries. 4000 w. Mines & Min—June, 1910. Serial. 1st part. No. 14559 C.

Notes on the Occurrence of the Ore Body at the City of Cobalt Mine. Frank D. Adams. Also short discussion. 1200 w. Jour Can Min Inst—1909. No. 15170 N.

The Origin of Laterite. J. Morrow Campbell. Information concerning the laterite formation in Africa, its relation to the rocks it covers, its origin, its relation to gold, etc. Ills. 4500 w. Inst of Min & Met. Bul. 67—April 14, 1910. No. 14353 N.

Criteria of Downward Sulphide Enrichment. F. L. Ransome. A critical examination of the lines of evidence by means of which the question whether or not the process has been operative in any given case may be answered. 5000 w. Ec-Geol—April, 1910. No. 14311 D.

Refractory Materials.

Defects in Refractory Brick and Their Causes. Gilbert Rigg. Considers in detail the properties refractory products should possess, and the principal defects. 1800 w. Met & Chem Engng—May, 1910. No. 13690 C.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

The Principles Governing the Arrangement of Automatic Block Signals. W. H. Arkenburgh. Considers the physical characteristics of a road and their relation to signal locations, and the relation of signals to each other. 4500 w. Ry Age Gaz—June 10, 1910. No. 14684.

The World Signal. J. H. Wisner, Jr. Read before the Ry. Sig. Assn. Illustrates and describes this system and explains its advantages. 1000 w. Ry & Engng Rev—June 18, 1910. No. 15009.

Progress in Interlocking Devices (Note sur les Progrès realisés dans l'Etablissement des Enclenchements). Pierre Lefort. A general review of interlocking problems and of the more important systems. Ills. 22000 w. Ann d Ponts et Chaussées—1910—II. No. 14802 E + F.

Train Staff.

Some Improvements to the Webb and Thompson Train Staff (Ueber einige Verbesserungen des elektrischen Zugstabes von Webb & Thompson). A. Tobler. Describes recent developments. Ills. 1800 w. Schweiz Bau—May 14, 1910. No. 14884 B.

MOTIVE POWER AND EQUIPMENT.

Continuous Propulsion.

Continuous Propulsion for Railway Trains (Les Trains automobiles à Propulsion continue). A. Doniol. Proposes a system in which the power of the locomotive is transmitted mechanically to the axles of the individual cars. Ills. 8000 w. Rev Gen d Chemins de Fer—May, 1910. No. 14819 G.

Electrification.

Present Status and Tendencies of Railroad Electrification in America. F. Darlington. Gives a short review of old and new electric railroad systems comparing their first cost and efficiency. General discussion. 5000 w. Pro Cent Ry Club—May 13, 1910. No. 15100 C.

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Freight Cars.

Steel Frame Box Cars. Illustrated description of cars in service on the Canadian Pacific Ry. 600 w. Am Engr & R R Jour—June, 1910. No. 14703 C.

Locomotive Bearings.

Removable Driving Box Bearing. Illustrated description, with report of results obtained and the advantages of the device. 1000 w. Ry Age Gaz—June 3, 1910. No. 14546.

Locomotive Boilers.

Report for France, Belgium, Italy, Spain and Portugal on the Question of Improvements in Locomotive Boilers. C. Dassesse. Deals with water-tubes, superheaters, valve gear and feed water heaters. Ills. 28000 w. Bul Int Ry Cong—May, 1910. No. 15267 G.

Report (No. 7) for Russia on the Question of Improvements in Locomotive Boilers. G. Noltein. Discusses water-tubes, superheating, valve gear, superheated steam and feed water. Ills. 40000 w. Bul Int Ry Cong—May, 1910. No. 15271 G.

Report for Russia, on the Question of Improvements in Locomotive Boilers. N. Antochine. Discusses the construction and maintaining tubes and tube plates, damages to boilers and their prevention, purification and treatment of boiler waters. Ills. 10000 w. Bul Int Ry Cong—May, 1910. No. 15266 G.

Inequality of Expansion in Locomotive Boilers and the Possibility of Eliminating the Bad Effects Therefrom. D. R. Mac Bain. Illustrations and discussion. 6800 w. Pro N Y R R Club—May 20, 1910. No. 14768.

Locomotive Construction.

The Roumanian Locomotive Competition. Presents the Belgian view of the recent competition instituted by Roumanian State Railway authorities for the delivery of 80 locomotives. 900 w. Engr, Lond—June 17, 1910. No. 15245 A.

Locomotive Explosions.

The Bertry Locomotive Explosion (Note sur l'Explosion de Locomotive de Bertry). M. Anglès-Dauriac. Describes the locomotive, its service, and the explosion, offering conclusions as to its cause. Ills. 5000 w. Ann d Ponts et Chaussées—1910—II. No. 14805 E + F.

Locomotive Fuels.

International Railway Fuel Association. Abstract of the report of S. L. Yerkes on "The Character of the Membership That Should Be Encouraged in the Association," and of other reports. 7000 w. Ry Age Gaz—May 27, 1910. No. 14490.

Locomotive Headlights.

Locomotive Headlights. C. H. Benjamin. An account of experiments made, discussing the results and pointing out the conclusions. General discussion. 14000 w. Pro W Ry Club—April 18, 1910. No. 14769 C.

Locomotives.

Mallet Articulated Compound Locomotive for the Delaware & Hudson Co. Illustrated detailed description and information concerning these powerful engines for pusher service on heavy grades. 5000 w. Ry Age Gaz—May 27, 1910. No. 14491.

Delaware & Hudson Articulated Compound Locomotives. Illustrated detailed description of these powerful engines for pusher service on grades. 3000 w. Mach, (Ry Ed)—June, 1910. No. 14718 C.

Very Powerful Articulated Compound Locomotive. Illustrated description of a design from which six locomotives for the D. & H. Co. have been built to operate on a grade between Carbondale and Ararat, Pa., where curves are numerous. 2500 w. Am Engr & R R Jour—June, 1910. No. 14702 C.

Northern Pacific Mallet Articulated Locomotives. Illustrated detailed description. 1200 w. Mach, (Ry Ed)—June, 1910. No. 14719 C.

Heavy Articulated Locomotives. A powerful Mallet Locomotive for the Northern Pacific is illustrated and described. 800 w. Am Engr & R R Jour—June, 1910. No. 14705 C.

Hybrid Mallet Units for the Erie and the Chicago Great Western Railroads. Diagrams and description of this plan for increasing the power of existing locomotives. 1200 w. Ry & Engng Rev—June 18, 1910. No. 15008.

Pacific Type Engine for the Chicago, Burlington & Quincy. Illustrated description of a heavy 4-6-2 engine equipped with superheater. 1000 w. Ry & Loc Engng—June, 1910. No. 14585 C.

A Metre-Gauge Compound Locomotive with Two Unequal Cylinders and Six Coupled Wheels (Locomotive tender compound à deux Cylindres inégaux et six Roues couplées pour Voie d'un Métre). R. Séguéla. Illustrated description. 1500 w. Rev Gen d Chemins de Fer—May, 1910. No. 14820 G.

See also same title, under STREET AND ELECTRIC RAILWAYS.

Locomotive Spark Arresters.

Sparking in Locomotives and Means of Prevention (Der Funkenwurf der Lokomotiven und die Mittel zu dessen Verhütung). Hermann Liechty. Discusses the causes of spark production and describes a number of locomotive spark arresters. Ills. 4000 w. Glasers Ann—May 15, 1910. No. 14891 D.

Locomotive Stokers.

The Successful Locomotive Mechanical Stoker: Pennsylvania Lines West of Pittsburgh. Outlines the requirements of a locomotive stoker, explaining the weak points in stokers generally, and giving a detailed description of the Crawford stoker which is pronounced successful.

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Ills. 6000 w. Ry Age Gaz—June 10, 1910. No. 14682.

Locomotive Superheating.

I. Tests of a Locomotive Using Superheated Steam; Atchison, Topeka & Santa Fe Railway. II. Steam Superheaters for Locomotives; Atchison, Topeka & Santa Fe Ry. H. B. McFarland. Abstract of a report reviewing the question of superheating and its development and giving particulars of comparative tests of engines with and without superheaters. Also editorial. Ills. 8500 w. Eng News—June 21, 1910. No. 14512.

Tests of Jacobs Superheater on a Tandem Compound Santa Fe Type Locomotive. A report of comparative tests made of an engine fitted with Jacobs superheater and reheater and an identical locomotive using saturated steam. Ills. 6500 w. Am Engr & R R Jour—June, 1910. No. 14707 C.

Superheaters. From the report on superheater tests issued by the motive power department of the A., T. & S. F. Ry. Ills. 4000 w. Ry & Engng Rev—June 25, 1910. No. 15219.

Locomotive Tests.

Front End Tests. Gives results of a series of tests to determine the best arrangement of front ends for Pennsylvania Atlantic type locomotives, Classes E2a and E3a. Diagrams. 500 w. Am Engr & R R Jour—June, 1910. No. 14706 C.

Locomotive Wheels.

Test of Locomotive Driving Wheels. E. L. Hancock. Illustrates and describes tests made in a Riehle testing machine of the deformation. 1500 w. Am Engr & R R Jour—June, 1910. No. 14704 C.

Motor Cars.

Benzol-Electric Motor Cars (Benzolelektrische Triebwagen). Hr. Beyer. Describes new cars of the Prussian State Railways. 2500 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15079 D.

Shops.

Railroad Shop Layouts. F. Kingsley. A discussion of the features that influence the relative location of the structures that make up an average railroad shop plant. 2500 w. Am Engr & R R Jour—June, 1910. No. 14701 C.

Organization of a Locomotive Repair Shop. J. B. Talmage. Describes the organization of the shops at Collinwood, Ohio, and considers some of the work accomplished. Ills. 2500 w. Yale Sci M—June, 1910. No. 14774 C.

The Installation of Flexible Staybolts. M. M. McAllister. Describes methods at the Collinwood shops of the L. S. & M. S. R. R. 1200 w. Boiler Maker—June, 1910. No. 15121.

Locomotive Building at Altoona. Ralph E. Flanders. Illustrates and describes the erection practice in the Juniata shops. 7000 w. Mach, (Ry Ed.)—June, 1910. No. 14717 C.

A Locomotive Rebuilt in 24 Hours. From the *Erie R. R. Emp. Mag.* Descriptive account of the work. 3800 w. Ry Age Gaz—June 3, 1910. No. 14545.

Car Repair Shop Notes from the Delaware, Lackawanna & Western at East Buffalo. Roy V. Wright. Illustrated description of shops, equipment, methods, etc. 3000 w. Ry Age Gaz—June 3, 1910. No. 14544.

Economy in Turning Wheels (Zur Wirtschaft des Radabdrehens). Herr Krause. Discusses the requirements in wheel-turning lathes and gives some figures of time and power requirements in actual practice. 2000 w. Glasers Ann—May 15, 1910. No. 14893 D.

Central Argentine Railway Workshops Electrification. Illustrates and describes the works at Rossario de Santa Fé. 1500 w. Engr, Lond—May 27, 1910. No. 14625 A.

See also Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Sleeping Cars.

The New Steel Sleeping Cars Built by the Pullman Co. Illustrated description. 1000 w. Ry & Engng Rev—June 11, 1910. No. 14712.

Train Lighting.

The Brown, Boveri & Cie. Electric Train Lighting System (Die elektrische Zugsbeleuchtung System Brown, Boveri & Cie.). Illustrated description of the apparatus and its arrangement. 3000 w. Elektrotechniker—May 25, 1910. No. 15057 D.

Train Resistance.

Freight Train Resistance and Its Relation to Average Car Weight. Edward C. Schmidt. Read before the Am. Ry. Mas. Mech. Assn. A report of tests, describing methods employed in the experiments. 6500 w. Ry & Engng Rev—June 25, 1910. No. 15220.

Wrecking Cranes.

20-Ton Steam Breakdown Crane. Illustrated description of a crane built for coupling to railway-stock and traveling with fast trains, and fitted with vacuum and hand brakes. 300 w. Engng—May 20, 1910. No. 14467 A.

PERMANENT WAY AND BUILDINGS.

Coaling Towers.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Curves.

Reliming Compound Curves. W. H. Wilms. Describes a method devised by W. R. Hillary, and found effective. 700 w. Ry Age Gaz—June 17, 1910. No. 14977.

Curve Easements; Present Practices. A summary of replies to questions showing the progress made in the United States, and the advantages. 3500 w. Ry Age Gaz—June 17, 1910. No. 14976.

We supply copies of these articles. See page 807.

Elevated Railways.

See same title, under STREET AND ELECTRIC RAILWAYS.

Landslides.

Remedies for Landslides and Slips on the Kanawha and Michigan Railway. R. P. Black. Describes the conditions in West Virginia, explaining the causes of slips and the remedies. 2000 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14940 E.

Rail Joints.

Report for Austria, Roumania, Bulgaria, Servia, Turkey and Egypt, on the Question of Rail-Joints. Friedrich Kramer. Considers reduction in number of joints by lengthening rails, welding, etc. Ills. 22000 w. Bul Int Ry Cong—May, 1910. No. 15269 G.

Stations.

Report for America on the Question of Large Stations. H. A. Jaggard. Considers track arrangements, appliances for handling goods, etc. Ills. 12700 w. Bul Int Ry Cong—May, 1910. No. 15270 G.

Terminals.

The Design of Terminals for Mechanical Freight Handling. H. McL. Harding. Suggestions, indicating the general principles of such designs. 4000 w. Eng Rec —May 28, 1910. No. 14422.

The Terminal Controversy at St. Louis. Samuel O. Dunn. An explanation of the situation at St. Louis, discussing points and merits of the controversy. 7000 w. Ry Age Gaz—June 24, 1910. No. 15153.

The New Chicago Station of the Chicago & North-Western Ry. Illustrated detailed description of a passenger terminal and approaches. 2500 w. Eng Rec —June 18, 1910. No. 14990.

The Winnipeg Railway Terminal Elevated Passenger Yard. Illustrated description of tracks, platforms, etc. 2000 w. Eng Rec—June 18, 1910. No. 14995.

Track Construction.

Report for Austria, Hungary, Bulgaria, Rumania, Servia, and Turkey on the Question of Strengthening the Track with a View to Increasing the Weight of Locomotives and the Speed of Trains. Hermann Rosche. Ills. 21900 w. Bul Int Ry Cong—May, 1910. No. 15268 G.

Track Maintenance.

The Health of Trackmen (Quelques Chiffres à propos de l'Hygiène des Cantonniers). M. Becker. A report on the mortality and health of maintenance-of-way employees on French railways. 7500 w. Ann d Ponts et Chaussées—1910—II. No. 14803 E + F.

Tunnels.

Railway Tunnels: Cross Sections, Grades, Lining and Drainage. Abstract of the report of the Committee on Roadway, presented at meeting of the Am. Ry. Engng. & Main. of Way Assn. giving information as to the practice of different railways. Also editorial. 7500 w. Eng News—June 2, 1910. No. 14515.

Turntables.

A 120-Ft. Turntable for Handling Mallet Locomotives with Their Tenders; A., T. & S. F. Ry. Illustrated description of a special type of turntable designed by Frank H. Adams. 1500 w. Eng News—June 23, 1910. No. 15135.

TRAFFIC.

Freight Classifications.

Car Load Ratings and Mixed Car Loads. R. N. Collyer. From a paper before the N. Y. Traffic Club. Suggestions and discussion of differences in classification principles. 5000 w. Ry Age Gaz—June 3, 1910. No. 14541.

Side Tracks.

Side Track Agreements. Louis Jackson. Discusses private side tracks for shippers, explaining the agreements. 1000 w. Ry Age Gaz—May 6, 1910. No. 13808.

Tonnage Rating.

Tonnage Rating for Fast Freight Trains. J. G. Van Zandt. Discusses methods of adjustment. 3500 w. Ry Age Gaz—June 17, 1910. Serial. 1st part. No. 14978.

MISCELLANY.

Accidents.

Compensation and Compensation Acts. Frank V. Whiting. Read before the Assn. of Ry. Claim Agents. Reviews the laws of various countries, and discusses features that have not been given proper attention. 2500 w. Ry Age Gaz—June 24, 1910. No. 15155.

Apprenticeship.

The Apprenticeship System of the New York Central Lines. C. W. Cross. From an address delivered before the Int. Master Boiler Makers' Assn., describing the system. 2200 w. Boiler Maker—June, 1910. No. 15122.

Argentina.

The Argentine Centenary. The present number reviews the railway development of the Argentine Republic. 2500 w. Engng —May 13, 1910. Serial. 1st part. No 14197 A.

Australia.

The Victorian Railways. Editorial review of the latest report of these Government Railways, showing the satisfactory condition. 2200 w. Engng—June 3, 1910. No. 14752 A.

Brazil.

The Railways of Brazil. Lionel Wiener. First of a series of articles on the railway development. 6500 w. Cassier's Mag —May, 1910. Serial. 1st part. No. 13955 B.

Depreciation.

The Necessity of Depreciation Reserves. Henry L. Gray. Gives the writer's views and conclusions reached after a study of the subject. 2000 w. Ry Age Gaz—May 27, 1910. No. 14489.

Education.

See same title, under INDUSTRIAL ECONOMY.

We supply copies of these articles. See page 807.

European Railways.

Continental Railway Investigation. The present number gives a report of Austria-Hungary. 1000 w. Engr, Lond—April 29, 1910. Serial. 1st part. No. 13865 A.

Exhibitions.

Some English Exhibits at Buenos Ayres Exhibition. First of a series of articles giving illustrated descriptions of some of the exhibits. 1200 w. Engr, Lond—May 6, 1910. Serial. 1st part. No. 13980 A.

Government Ownership.

Impending Changes in the British Railway System. W. M. Acworth. The report of the Board of Trade Ry. Conference presented to both Houses of Parliament by command of his Majesty. Also editorial. 6000 w. Eng News—May 19, 1910. No. 14122.

Graphical Charts.

Graphical Study of Information. Prof. H. Wade Hibbard. An explanation of the plotting into diagrams of data of every sort. Ills. 4000 w. Pro W Ry Club—March 15, 1910. No. 14277 C.

Legislation.

Main Points of the New Railway Law. A statement concerning the law that takes effect Aug. 18th, 1910. 500 w. Ry Age Gaz—June 24, 1910. No. 15154.

Norway.

The New Christiania-Bergen Railway (Die neue Hochgebirgsbahn von Kristiania nach Bergen). Sigvard Heber. Describes a line through mountainous country. Ills. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14236 D.

Organization.

The Motive Power Department Organization of the Chicago, Burlington & Quincy. M. K. Barnum. Charts, showing graphically the relations, with explanations. 3000 w. Ry Age Gaz—May 6, 1910. No. 13811.

Panama.

The Panama Railroad and Its Relation to the Panama Canal. Ralph Budd. Reviews briefly the history of transportation facilities across the isthmus, describing the building and rebuilding of the railroad, the relocation of the line, unusual features of construction, etc. An Historical Sketch by Joseph E. Murphy is given. Also general discussion. Ills. 11500 w. Jour W Soc of Engrs—April, 1910. No. 14327 D.

Purchasing.

See same title, under INDUSTRIAL ECONOMY.

South America.

Railway Development in South America. Information concerning the railroad lines of the different countries. 3500 w. Ry & Engng Rev—May 7, 1910. No. 13805.

Statistics.

The Necessity of Care in the Interpretation of Railway Statistics Used Comparatively. Ernest Ritson Dewsnup. A survey of important statistics showing their limitations. 7500 w. Ry Age Gaz—May 13, 1910. No. 13900.

Statistics of Railways for Year Ended June 30, 1908. Editorial review of the twenty-first annual report. 1200 w. Ry Age Gaz—June 3, 1910. No. 14540.

STREET AND ELECTRIC RAILWAYS.

Brake Shoes.

Brake-Shoe Standardization. J. A. Panton. Read before the Tram. & Lgt. Rys. Assn. Considers types and present-day requirements, explaining the saving that could be effected by standardization. Ills. 5000 w. Tram & Ry Wld—June 2, 1910. No. 15112 B.

Car Maintenance.

Rolling Stock Maintenance Organization of the Massachusetts Electric Companies. Gives diagram showing the general organization, forms used, reports, etc., with explanatory notes. 2000 w. Elec Ry Jour—June 4, 1910. No. 14537.

Economics.

City Transportation. Frank Foster. Problems due to municipal congestion are discussed. 2500 w. Cassier's Mag—June, 1910. No. 14643 B.

Tramway Economics. J. R. Salter. Read before the Tram. & Lgt. Rys. Assn. Deals with the relation between receipts, car-mileage and working expenses, and the general commercial principles involved. 6000 w. Tram & Ry Wld—June 2, 1910. No. 15113 B.

Elevated Railways.

Reconstruction of Part of the Manhattan Elevated Railway. Illustrated description of the work of depressing an elevated railway on each side of Manhattan Bridge, New York, to increase the clearance at its intersection with the Second Ave. line. 1500 w. Eng Rec—May 28, 1910. No. 14417.

Replacing and Depressing the Manhattan Elevated Railway. Illustrates and describes work in New York City to provide clearance for the elevated railway trains under one of the approach spans of Manhattan Bridge. 3500 w. Eng Rec—June 11, 1910. No. 14688.

Carrying an Elevated Railway Across a Skating Rink by a 100-ft. Truss Span. Plans and description of work in Chicago, by which the Metropolitan Elevated Ry. is carried across a skating rink at Paulina

We supply copies of these articles. See page 807.

Street. 800 w. Eng News—June 16, 1910. No. 14913.

A Long Reinforced-Concrete Railway Viaduct Through the City of Rotterdam, Holland. Illustrated description of a viaduct about 5300 ft. long, carrying a two-track heavy electric-railway line. 1200 w. Eng News—June 16, 1910. No. 14907.

See also Operation, under STREET AND ELECTRIC RAILWAYS.

Interurban.

Traffic and Physical Development of an Iowa Railroad. Illustrated account of the system of the Ft. Dodge, Des Moines & Southern Railroad Co. which operates a combination steam and electric railroad. 2000 w. Elec Ry Jour—June 25, 1910. No. 15152.

Italy.

Electric Traction on the Giovi Railway (La Trazione elettrica ai Giovi). The first part describes the central station for this line out of Genoa. Ills. Serial. 1st part. 3000 w. Ing Ferro—May 16, 1910. No. 14852 D.

Locomotives.

Electro-Mechanical Locomotives. A. P. Chalkley. Illustrated discussion of the possibilities of combination electric propulsion. 2000 w. Cassier's Mag—June, 1910. No. 14638 B.

Running a N. Y., N. H., & H. Electric. W. B. Kouwenhoven. Brief description of the equipment and operation of one of these electric locomotives. Ills. 2500 w. Ry & Loc Engng—June, 1910. No. 14584 C.

The Electric Locomotives of the Wengern Alpine Railway (Die elektrischen Lokomotiven der Wengernalpbahn). H. Morgenthaler. Description of locomotives for a Swiss rack railway. Ills. 4000 w. Schweiz Bau—May 28, 1910. No. 14885 B.

Electric Locomotives on the Dessau-Bitterfeld Line (Die Lokomotiven der elektrischen Zugförderungsanlage Dessau-Bitterfeld). W. Heyden. Describes passenger and freight locomotives. Ills. 2500 w. Elek Kraft u Bahnen—May 24, 1910. No. 15062 D.

Maintenance.

Care and Handling of Electrical Equipment, New York Central & Hudson River. F. E. Lister. Describes interesting features of care found necessary in the maintenance of the equipment for the 58 miles of its electric division into New York City. 4000 w. Ry Age Gaz—June 3, 1910. No. 14547.

Management.

The Transportation Department of the Metropolitan Street Railway, New York. An illustrated account of improvements introduced in the transportation methods. 3000 w. Elec Ry Jour—June 25, 1910. No. 15151.

Mono-Rail.

The Mechanical Principles of Brennan's Mono-Rail Car. Henry T. Eddy. Aims to develop the mathematics and physics of the gyroscope, and their application to this car. Ills. 5000 w. Jour Fr Inst—June, 1910. No. 14922 D.

Mono-Railways (Einschienenbahnen). E. A. Ziffer. A review of the various systems proposed. Ills. 5200 w. Mit d Ver f d Förd Lokal u Strassenbahnwesens—April, 1910. No. 14853 F.

Operation.

Passenger Traffic Handling on Elevated Trains at the Manhattan Terminal of the Brooklyn Bridge. Explains the highly efficient train and passenger handling system that has been developed to meet the unusual requirements. 2000 w. Eng News—May 26, 1910. No. 14401.

Railless.

Railless Traction. Harry England. Discusses the use for suburban car service. 4000 w. Tram & Ry Wld—June 2, 1910. No. 15114 B.

The Trackless Trolley System in Italy. Illustrates and describes details of the Filovia system in Italy. 700 w. Tram & Ry Wld—June 2, 1910. No. 15111 B.

Mercedes-Stoll Trackless Trolley System. Illustrates and describes applications of this system, giving details of lines at work. 800 w. Tram & Ry Wld—June 2, 1910. No. 15110 B.

Subway Cars.

Center Side Door Steel Cars for New York Subway. Illustrated detailed description. 3000 w. Elec Ry Jour—June 18, 1910. No. 14968.

Subway Signalling.

Speed Control Signals on the Interborough. Extracts from a talk by J. M. Waldron on the arrangements introduced on the express tracks of the subway in Manhattan by which trains can safely be run closer together. 1200 w. Ry Age Gaz—June 17, 1910. No. 14979.

Track Maintenance.

Some Suggestions for Economical Track Maintenance and Construction. Martin Schreiber. Illustrated discussion of practical ideas in connection with track work. 2200 w. Elec Ry Jour—June 18, 1910. No. 14967.

Trolley Lines.

Brooklyn Line Department—The Novel Iron-Bar Overhead Construction. Illustrated description of this bar construction, which is used wherever traffic is heavy and at important intersections. 800 w. Elec Ry Jour—June 11, 1910. Serial. 1st part. No. 14673.

Wire Suspension.

Electric Railway Catenary Trolley Construction. W. N. Smith. Reviews current practice, calling attention to features that seem to be open for discussion. Ills. 9000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14954 F.

We supply copies of these articles. See page 807.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brickbuilder. *m.* Boston.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Commercial Vehicle. *m.* New York.

Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. N. E. Water Works Assn. *qr.* Boston.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *w.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Rudder. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yale Scientific Monthly. *m.* New Haven.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.